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

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Headquarter: The Secretary
East African Examinations Council
P. O. Box 7066, Kampala
UGANDA
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Regional Office: The Deputy Secretary
East African Examinations Council
P. O. Box 73598, Nairobi
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THE COUNCIL AND ITS CONSULTATIVE MACHINE:

1. The East African Examinations Council:

The Council consists of a Chairman, who is the Vice-Chancellor of one of the Universities of East Africa (the office is held in rotation for a period of three years), six members appointed by the Senates of the three Universities, three members appointed by each of the three Governments of East Africa, two Heads of Schools from each of the three countries of East Africa, two representatives of the East African Community, and one representative of the University of Cambridge Local Examinations Syndicate.

2. The Technical Examinations Committee:

The Technical Examinations Committee of the Council is responsible for the following:-

entry regulations, regulations for award of certificates, forms of certificates awarded by the Council, approval of subjects to be examined, subject syllabuses prepared by International Advisory Committees, appointment of examiners and approval of Technical examination centres.

The Committee consists of a Chairman elected from the members. The Committee membership includes the following:-

(a) Three representatives appointed by the three Governments partner states.
(b) Three representatives from the Universities of East Africa.
(c) Three Principals or their representatives of the Technical Colleges in East Africa.
(d) Two representatives from East African Community.
(e) One Director of Industrial Training Board of each partner State.
(f) One representative of the Federation of employers from each partner State.
(g) One representative from East African Institute of Engineers.
(h) The Secretary to the Council.

3. International Advisory Committees:

The Council has International Advisory Committees to cover every subject or group of subjects examined. Each committee includes appropriate representatives from each country, examiners and professional men. The International Advisory Committees are responsible for drawing up and revising syllabuses and receiving criticisms and suggestions concerning existing syllabuses. They also work closely with the National Advisory Panels which are responsible for devising syllabuses suitable for their respective countries. The Secretary to Council or his representative is an ex-officio member of each Committee.

4. National Advisory Panels:

There are National Advisory Panels in each of the three countries whose function is to advise the Government on the examinations to be made available in the country and to make representations as appropriate to the Council in regard to the examinations and other matters with which the Council is concerned. Each country appoints members to its National Advisory Panels.

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 660 hours of technical studies and 120 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 660 hours of technical studies and 120 hours of General Studies) provides for further study and the Part III (about 360 hours of technical 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, Sales 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 60 hours per year to them in Part I and II, and up to 90 hours per year where local conditions make this possible. 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 and preferably 78 weeks.

(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 Paper I	2½ hrs.
1022/02	Technology Paper II	2½ hrs.
1022/03	Drawing & Practical	2½ 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 Paper I	3 hrs.
1022/11	Technology Paper II	3 hrs.
1022/12	Drawing & Practical	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 Supervision and Motor Trade Practice	
1022/21	Commercial Practice & Law	3 hrs.
1022/22	Project work assessment	3 hrs.

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 submision 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.

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 tightening 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.
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; gear 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 Ministry of Transport Certificate: compilation of reports.

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 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 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 offrings. 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 standards of the Ministry of Transport Certificate 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 vies 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 formulae and their manipulation, workshop applications.
Angles and their notation (excluding radian notation) up to 360^0.
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 0^0, 30^0, 45^0, 60^0 and 90^0; 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 starred 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 bavel 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. Multi-grade 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. Quantitative relationship between pressure, volume, 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 temparuture readings on Fahrenheit and Celcius 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 (gearboxes, 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 VAD = VAB + VBC + VCD.
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 It = Ia + Ib + Ic.
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 rate of 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 coil-ignition 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 badly adjusted contact breaker points; a disconnected condenser; a leaking high-tension 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 four wheels.
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 flywheels, 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 superchargers.
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.
Inspection of engines and other mechanical components for wear and incorrect adjustment.
Diagnosis of faults by inspection and/or road test. Checking speedometers and tachometers.
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.
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.
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.

Scheme of Practical Work

Thrid Year

Examining of engine parts 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.

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.

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 circule, 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 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 $ax^2 + bx + c = o$, 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 accelaration.
Surface areas, volumes and weights of common solids for prismoidal, cylindrical, conical and spherical shapes.
Sine, cosine and tangent of angles from 0° to 360°. 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 unformly 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 combution 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).

(ORGANIZATION AND ADMINISTRATION)

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.

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.

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.

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.

8. Motor Trade Practice

WORKSHOP ADMINISTRATION AND ORGANIZATION

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.

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.

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 self-service installations.

11.2.1. Qualifications and responsibilities of forecourt staff.

11.3.1. Overhead costs, operation costs and profitability.

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.

C Commercial Practice and Office Procedure

THE OFFICE

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.

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.

3.2.1. 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.

D. 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 beyong 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 25 hours of work by each student IN ADDITION to the 360 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.

THE EAST AFRICAN EXAMINATIONS COUNCIL

REGULATIONS AND SYLLABUSES

1025

CONSTRUCTION PLANT TECHNICIANS

CERTIFICATE

THE EAST AFRICAN EXAMINATIONS COUNCIL

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Mr. Peter J. Gachathi, Permanent Secretary,
Ministry of Education – Kenya

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Regional Office, Kenya.

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CONSTRUCTION PLANT TECHNICIANS CERTIFICATE

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CONSTRUCTION PLANT TECHNICIANS CERTIFICATE

Introduction

1. 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 construction plant industry to develop an ability to diagnose faults, recommend means of rectifying these faults and to test an analyse the performance of the plant after 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:

Course of Study

2. 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 Studiess) gives a broad introduction to the theoretical and practical aspects of construction plant 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 1170 hours of technical studies and 78 hours of General Studies) provides for further study, and the Part III (about 520 hours of technical studies) is designed to enable the student on completion of his technical studies and concurrently with suitable experience, to study basic organisation and administration of the three main developments within the construction plant maintenance organisation, Parts, Sales and Service. This will serve as an introduction preliminary to his taking full administrative responsibilities later in his career. The Part III Certificate is Full Technological Certificate requirement.

3. The topics of the course are shown below:

PART I
- (a) Plant Technology
- (b) Prime Movers Technology
- (c) Mechanical Engineering Technology

Practical Work for a, b & c
Sketching and Drawing
Mathematics
Science
Laboratory Work (See Appendix B)
General Studies.

PART II
- (a) Plant Technology
- (b) Prime Movers Technology

Practical Work for a & b
Mathematics
Science
Laboratory Work (See Appendix B)
General Studies.

PART III
Parts Marketing and Sales
Principles of management
Construction Plant Practice
Commercial Practice and Office Procedure
The Law Relating to the Construction Plant.

4. Course Work consisting of Class Work Laboratory and Practical Work and General Studies is regarded as an integeral part of the course. With General Studies (See para I) the aim should be to allocate about 60 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 Course "Maintenance and Repair of Construction Plant Mechanics (620)."

Entry to Course

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

Part I
- (i) East African Certificate of Education issued by the E.A.E.C. at Ordinary Level in English, Mathematics and approved Science Subject with credit passes.
- (ii) Part 1 Certificate in Maintenance and Repair Construction Plant 620 with Credit.
- (iii) Appropriate academic ability in a mature student.

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

A pass in Part I examination Construction Plant Technicians.

A pass in Maintenance and Repair of Construction Plant 620 Part II with Credit.

Part III A pass in Construction Plant Technicians Part II examinations.

Countries Outside East Africa

7. 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 the appropriate form issued by the E.A.E.C.

8. 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 to have four papers as follows:

1025/01 Construction Plant Technology I (Theory & Practice)	3 hours
1025/02 Construction Plant Technology II (Theory & Practice)	3 hours
1025/03 Engineering Drawing and Maths	3 hours
1025/04 Engineering Science (Theory & Practice)	3 hours

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 precribed 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;

PART II to have four papers as follows:

1025/10 Construction Plant Technology I (Theory & Pract.)	3 hours
1025/11 Construction Plant Technology II (Theory & Pract.)	3 hours
1025/12 Engineering Drawing & workshop Practice	3 hours
1025/13 Engineering Science & Science Practical	3 hours

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

PART III to have three papers as follows:
1025/20 Principles of Management
1025/21 Workshop Organisation and Administration
1025/22 Commercial Practice
1025/23 Projectwork

11. Referal

A candidate who fails by a small margin in one subject, may be referred in that subject, provided the candidate satisfies the conditions and regulations of the awards laid down by the council.

A candidate who fails in two or more papers must resist the entire examinations.

Candidates can be referred in papers
(i) 1025/03 or 1025/04
(ii) 0125/12 or 1025/13 only

Entry for Examinations.
The E.A.E.C. will not accept any entry from an individual applicants. Candidates must submit their entries through an examination centre on the prescribed form obtainable from the Centre. Entries must reach the by 30th April for July examinations, and 30th September, for December examinations.

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 and have further satisfied the authorised assessors that they are capable of attempting the examination.

Late entries subject to an additional fee may be accepted at the discretion of the E.A.E.C;

Records of Students Work

COURSE WORK ASSESSMENT

12. Course work Assessment

The final grade of pass will be computed on the basis of 70% of the total Examination marks and 30% of the coursework assessment. The course-work Assessment marks will be computed from:

60% controlled class tests

30% classwork or laboratory or Practical work
10% home 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 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 works. (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 access the standard of English used by the candidates.

15. Results and Certificate

Results in the examinations as a whole will be issued in four classes and for the individual papers including course work, in each 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 perfomance for PartsI, II & III giving the result in terms of class and grade.

Parts aI, II and III Certificate 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 certificates will show the class of and also the names of the subjects passed Students sitting for the internal C.P.T. Part I will be advised by the institution concerned of their results for the examination.

16. 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.

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 Construction plant equipment 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 plant after the repair or modification has been completed.

2. The technology (a, b & c) 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 construction plant 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 construction plant vehicle problems but the teaching of all subjects should not be taken beyond the depth necessary to support the construction plant 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 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 more verbal descriptions the results already fully presented in numerical, tabular, or graphical form).

3. Students should be required to write formal reports on at least one workshop tasks 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 construction plant repair industry covered in the Part III syllabus and should entail a total of approximately 25 hours of work by each student IN ADDITION to the 500 hours envisaged for the course. The project will be assessed by the E.A.E.C. and such assessement will be used in the determination of examinations 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 centre and submitted through the Local Examinations Officer on the prescribed form.

Refferement: Candidates can be referred on either paper 1025/12 or 1025/13 only, provided the candidates satisfy the conditions of the awards laid down by E.A.E.C.

CONSTRUCTION PLANT TECHICIAN'S PART 1
TECHNOLOGY

PRIME MOVERS

The main components of the I.C. engine. The principle of operation of the I.C. and S.I. engines on the four and two stroke cycles. Elementary reasons for the use of more than one cylinder. Consideration of typical engine layouts, arrangements of cylinders and crank throwers. Common valve arrangements and mechanisms.

Functions of the main items of electrical equipment. The action of a coil ignition system and magneto.

The petrol supply system (layout). The simple carburettor.

The layout of the C.I. fuel system. The need for filtration and bleeding.

The thermo - syphon water cooling system, use of water pump.

The single plate friction clutch, construction and operation. Characteristics of the I.C. engine which demands use of a clutch.

The gearbox. Engine and load characteristics which demand its use. Sliding mesh and constant mesh gearboxes.

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

Final drive. Types of drive used in wheeled plant and reasons. The transmission of the drive through differential gears, reasons for having the differential gears and the action of the differential. Construction and action of a differential lock.

Methods of axle shaft support i.e. semi-floating, three quarter floating and fully floating axle Shafts.
The front axle and steering system. Conditions necessary for true rolling of all wheels. Simple beam axle with Ackermann linkage. Steering gearboxes.

Types of braking systems in common use. Drum and disc brakes.

Lamps used in plant vehicles, aligning and focussing, anti-dazzle devices. Types of cables, connectors and fuses with reference to current carrying capacity. Lead acid batteries, brief description of plates, separators and containers. Composition of and preparation of electrolyte. Use of hydrometer. Common battery faults. Testing and care of lead acid batteries. Effect of high and low temperature on charging and discharging.

Engine construction. Cyclinder blocks, head and gaskets. Wet and dry liners. Pistons, types of rings, location and clearances, gudgeon pins and their location. Connection rods and bearings, crankshafts. Overhead camshafts. Types of combustion chamber on C.I. Engine. Comparison of C.I. and S.I. Engines.

S.I. engine fuel systems. Types of petrol pumps. Types of carburettors, methods of controlling mixture strength, air bleed, compound jet, variable choke, cold starting, slow running acceleration and economy devices.

C.f. engine fuel injection equipment. In line fuel injection pump, construction and operation. Control of engine speed and power by means of a simple governor. Phasing and calibrating. Injectors and nozzles. Fuel lift pumps and fuel filters.

Lubrication. Use of force feed lubrication. Types of oil pumps, relief valves, and oil filters. Oil gauges and warning lights. Dry sump lubrication. Properties of lubricants. S.A.E. classification. Causes and effects of excessive oil consumption.

Cooling system. Air cooled engines. Pressurised water cooling systems, details of water pump, radiator pressure caps, and thermostats.

Nickel iron alkaline batteries. Advance and retard mechanisms. Detail of sparking plugs and their selection. Ignition timing. Simple starter motors and inertia drives. D.C. generators and regulators. Including cut-out.

Details of clutch centre plates and friction materials.

Principles underlyingg castor, camber, wheel alignment and king pin inclination.

Brakes. Leading and trailing shoes. Friction lining materials. Brakes phase. Layout of hydraulic system and detail of master cyclinder and wheel cyclinders.

CONSTRUCTION PLANT TECHNICIAN SYLLABUS PART I
TECHNOLOGY

PLANT

An appreciation of all types of construction plant that exists i.e. small plant, water pumps, diaphragm and centrifugal drum pan mixers, vibrators, rollers tampers and pokers. Heavy plant, prime-movers tanker trucks, fork and various loaders, scrapers, graders entrenching machines,concrete mixers,asphalt finishers asphalt kettles,fork lifts, earth movers, earth augers, motorised saws and compressors.

Layout of transmission systems in vehicles and plant.

Principle of dog clutch, cone clutch, expanding shoe, centrifugal clutch and controll mechanisms and adjustments.

Common methods of suspension used in plant. Live and dead axles, elliptical and coil springs and torsion bars. Methods of damping.

Wheels and tyres, construction and size. Selection for use, fitting, wet and dry ballasting.

Brakes, mechanical systems, band brakes

Hydraulics. Principle of operation of simple circuits. Functions of pump, motor, reserviour, filter, relief valve, directional control valve and cyclinders in simple circuits. Filling and bleeding.

Compressors. Types of rotary and reciprocating pneumatic tools used, their construction and operation, importance of filters, strainers and lubricators.

Starting systems. Types of torque limiting clutches. Switches and protective devices, construction of manual and relay controlled switches, overload devices and circuit breakers; Donkey Engines and compressed air starting systems.

Hydraulics. Types of pumps and motors, valves, cyclinders and methods of sealing, types of seals, filters and strainers. Ridged and flexable pipes and their fittings. Properties of fluid, avoidance and detection of contamination.

Fluid transmission. Fluid couplings i.e. fluid flywheel and torque convertor, their construction and operation. Simple treatment of power shift gearbox.

CONSTRUCTION PLANT TECHNICIANS' COURSE PART I
MECHANICAL ENGINEERING

General workshop regulations, legal requirements relating to safety. Basic safety precautions on machinery, lifting tackle, jacking etc.

Common fitting tools care and use. Marking out tools care and use. Properties of common irons and steels, effect of properties on uses. Identification by workshop methods. Basic cutting action and tool angles for bench tools. Methods of sharpening. The care and use of twist drills. Types of screw threads, and uses in plant. Use of Screw thread tables. Hand cutting screw threads.

Methods of measurement in the workshop. Micrometer and vernier scales; action, care and use of internal and external micrometers; care and use of vernier caliper, high and depth gauges, cylinder bore gauges, telescopic gauges and Go- and No-Go gauges.

An appreciation of machine shop processes. = Tools as used in turning. The use of the centre lathe for turning between centres and simple chuck and face plate work. Simple grinding and milling operations.

Solders and fluxes and their uses; composition of common solders; common methods of soldering.Precautions in the repair of fuel tanks.

Welding techniques: safety regulations and precautions relating to gas welding. Application of welding and cutting techniques to plant repairs. Gas welding of cast iron by fusion welding and bronze welding.

Electric Arc Welding, safety regulations and precautions. AC and DC current and voltages, choice of electrodes. Weld testing.

Air compressors and tools. Elements of workshop compressed air system. Types of compressors, rating, pressure control, cooling servicing and fault diagnosing, valve unloader, intercooler, receives, filter and water traps, pipe, hoses and connectors. Lubrication, maintenance, safety regulations.

Lifting gear, hoist and crane type winches and pile drives driving and breaking mechanisms. Mechanical, hydraulic and pneumatic operating linkages. Steel and fibre ropes, care, maintenance and inspection, protection and storage. Sling spreaders and rope anchors. Sheer legs, derricks and gantries. Lifting jacks. Types of cranes in common use. Safety devices and factors of safety.

CONSTRUCTION PLANT TECHNIIANS' SYLLABUS PART I

PRIME MOVERS PRACTICAL

Dismantling a single cylinder, four stroke engine and a two stroke S.I. and C.I., engines. Noting the sequence of operations and function of each part. Assemble of the same engines. Inspection of valve arrangements and operating mechanisms. Setting tappet clearances. Inspection of the main items of electrical equipment, including wiring details and connections of a typical coil ignition system. Dismantling and re-assembling a distributor and magneto. Cleaning and adjusting sparks plugs and distributor contact gaps to specification. Inspection of a typical fuel supply system for an S.I engine. Inspection of a typical fuel supply system for a C.I. engine and bleeding of this system.

Dismantling and re-assembling the cooling system of a four cyclinder engine 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 of a three or four speed gear box of both the sliding mesh and constant-mesh types, noting the sequence of operation and the name and functions of each part. Particular reference should be made to the methods of engaging gears and any provisions for adjustments. Re-assemble of the same gearbox.

Dismantling universal joints noting the sequence of operations and 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 functionsof 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. Inspection of methods of axle shaft support. Inspection of a differential lock.

Dismantling and re-assembling 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 the braking system. Dismantling the components, noting the name and functions of each part. (Both drum and disc brakes). Re-assembling the brakes with particular reference to provision for adjustment. Examination of various types of bulbs and vehicle lamps. Provision for alignment of head lamps. Dismantling, examining and re-building a demonstration lead acid cell noting the function of each part and the material of which it is made. The use of values of specific gravity and voltage to assess the state of charge and general condition of cells.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART I

PRIME MOVERS PRACTICAL

Complete dismantling and re-assembly of an engine to include the following; Examination of all part listed under technology. Valve grinding and valve seat placing. Checking alignment of connecting rods and rectification. Measurement and gauging of cylinder bores, crank shafts, cam shafts and bearings. Correct selection of pistons, fitting of rings. Setting up and boring cylinders to specified oversize.

Stripping C.I. engine for inspection. Re-assembly. 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, re-assembling 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 values. 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 re-assembling of common types of mechanical and electrical diaphragm pumps. Testing for satisfactory operation. Dismantling, inspecting and re-assembling a variable-choke and a constant choke carburettor noting any special features and adjustments. Examination and test of a complete coil ignition system using modern analysing equipment. Recognition of dis-

tributors. Timing to engine and reconnecting leads. Testing faulty spark plugs in a pressure chamber in conjunction with the oscilloscope.

Overhaul of interia engagement starters followed by correct testing procedures. Dismantling fuel injection pumps (in line), checking components, re-assembly, 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 of a clutch jig.

Checking of wheel alignment, castor, camber, and King Pin Inclination. Measuring turning angles as a means of insuring correct setting of steering linkages. Dismantling and re-assembling of brakes, bleeding of hydraulic systems. Examination and testing of D.C. generators. Examination, testing and adjustment of output control units for the D.C. generator.

CONSTRUCTION PLANT TECHNICIANS' COURSE PART I

PLANT PRACTICAL (APPLIED PLANT TECHNOLOGY)

Inspection of the layout and the main components of all types of construction plant equipment.

Inspection of the layout and the main components of transmission systems in vehicles and plant.

Dismantling and re-assembling of a dog clutch, cone clutch, expanding shoe clutch and control mechanisms, and necessary adjustments.

Dismantling and re-assembling of common suspension systems used in plant. Removing and replacing tyres and wet and dry ballasting of the wheels. Dismantling and re-assembling of mechanical brake systems including the band brake and make the necessary adjustments.

Dismantle, inspect and re-assemble simple hydraulic circuits to include directional control valves. Examination of faults. Examination of filters. Dismantle, inspect and re-assemble a pressure relief valve. Dismantle and inspect a hydraulic system on an item of construction plant, re-assembling and bleeding the system to remove air locks stressing the importance of asbolute cleanliness.

Inspection of compressors. Dismantling and re-assembling, of rotary and reciprocating tools used with compressors.

Inspection of starting systems. Dismantling and assembling of torque limiting clutches, switches and protective devices, overload devices and circuit breakers.

Inspection of hydraulic pumps, motors, cylinders and rams. Inspect and establish hydraulic circuit on an item of contractors plant with particular reference to safety and cleanliness. Correct assembly of seals and glands.

Inspection of a simple air system. Dismantle and inspect a compressor. Air lines. Fitting new couplings and testing, stressing cleanliness and safety. Demonstrate the detrimental effects of dirt in a pneumactic tool, clean and re-assemble.

Flaring of hydraulic pipes. Fitting of pipe unions. Preparation of flexiable hose and attachment of re-usuable and fitting.

Dismantling and assembling of a fluid fly wheel, noting its action, type of fluid used and its movement through the vanes and passages. The faults and maintenance of a fluid fly wheel.

Examination of the components of a torque convertor noting their actions. Type of fluid used and its movement through the torque convertor. Inspection of the three stage torque convertor. Routing maintenance stock. Recognition of a faulty torque convertor.

Inspect the track and track drive systems on a tracked vehicle. Method of adjustment, replacement, lubrication and maintence of track running gear.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART I

MECHANICAL ENGINEERING WORKSHOP PRACTICE

Common fitting tools, their care and use. Methods of sharpening bench tools. Grinding machine safety precautions. Instruction in simple marking out; use of measuring instruments including micrometers (internal and external) vernier caliper, height and depth gauges, cylinder bore gauges, telescopic gauges.

Use of powered hand tools electric and pneumatic. Simple exercises on marking out, drilling and drawing of holes use of taps , stocks and dies.

Workshop tests to identify common irons and steels and to show their physical properties.

Use of the centre lathe for turning between centres, simple chuck and face plate work.

Simple grinding and milling operations. Soft and hard soldering. Joints and patches in sheet metal, nipples on steel and copper pipes. Making, insulating and finishing a soldered joint in electric cables. Repair of fuel tanks.

Use of gas welding equipment, depositing straight beads of weld metal. But, fillet and lap welds on mild steel plates. Flame-cutting. Gas welding of cast iron by fusion and bronze welding.

Use of arc welding equipment. Selection of current and voltages, choice of electrodes, weld testing, spot welding. Dismantling and assembling of compressors. Servicing and fault diagnosing, inspection of valve unloader, inter-cooler, receivers, filters and water traps, pipes, hoses and connectors. Lubrication and maintenance. Inspection of the layout of hoist and crane type winches. Dismantling and assembling driving and braking mechanisms. Dismalting and assembling and adjusting of mechanical, hydraulic and pneumatic operating linkages.

Anchoring and threading of rope. The inspection, fault diagnosis and fault rectification of a rope layout on items of plant. Inspection and use of sheer legs dericks, gantries, lifting jacks and types of cranes in common use.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART 1

DRAWING AND SKETCHING

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 drawing. 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 plant technology.

Application of the principles of sketching and drawing to the production of engine; gear box, rear axle, braking, steering and suspension layouts and to dimensioned sketches of the components of the 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 plant e.g. screw threads, springs, gear wheels, ball bearings.

Electrical symbols and diagrams to B.S. 3939. Welding symbolts to B.S. 499.

Use of cross sectional views. Applications to the units dealt with in plant 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 drawing of electrical components. Sketches and drawings of various types of clutches and operating mechanisms; gear boxes and steering boxes.

Line diagrams illustrating engine lubrication systems; valve arrangement and cam shaft drives; fuel supply systems; cooling systems; electrical circuits.

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.

CONSTRUCTION PLANT TECHNICIAN' SYLLABUS PART 1

MATHEMATICS

Volume. Weight. Capacity. Decimalisation. Percentages. Ratios. Direct, indirect and joint proportion.

Expressions, equation and formulae. Solution of simple equations. Straight line graphs.

Simultaneous equations and solution by graphical means. Indices and logarithms.

Ratio in geometry. The sine, cosine and tangent. Use of trigonometry tables. Solution of right angled triangles. Area of triangle in the form ½bc sin A. Transposition of formulae. Use of logs in solving transposed equations. Slide rule. Square roots. Reciprocals of numbers.

Volumes and weights of rectangular solids and cylinders.

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

The principles of the micrometer and of vernier scales.

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

Ratio and proportion in geometry. Intercept theorem. The circle and cylinder. Ratio of circumference to a diameter. Area of a circle. Surface area of a cylinder. Circular measure. Use of tables to convert to degrees. Length of arc of circle. Area of sector of segment of circle. Mensuration problems.

Quadratic equations.
Harder straight line graphs. The parabola and hyperbola. Slope of tangent at a point.

Graphical problems appropriate to the course. Area under a curve Mid-ordinate rule and Simpsons rule. Intersecting cords of a circle. Rectangle problems. Mensuration of uniform cross section.

The sine and cosine rules for solution of triangles.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART I

ENGINEERING SCIENCE

HEAT AND PROPERTIES OF MATTER

Nature of heat, conduction, convection and radiation. Measurement of tem temperature, use of mercury in glass thermometers. Quantity of heat and units o of measurement. Calculations of specific heat, including simple heat energy lost or gained. Expansion and contraction of solids, liquids and gases when heated and cooled. Coofficient of linear expansion.

Simple treatment of the relationship between pressure, volume and temperature of gases in the combusion process of the C.I. engine, absolute pressure.

Change of state, melting and solidifiction, evaportion and condensation. Simple explanation of formation of steam at a constant pressure, simple treatment of humidity. Comparision of melting point of common metals.

Freezing and boiling points of water, fuel oil, petrol, ant-freeze solution and electrolytes.

Relative density and density of solids and liquids.

Simple concepts of the discharge of liquids and air through pipes and orifices due to pressure differences. Simple transmission of force, pressure, and energy by a fluid. The hydraulic ram and press. Factors affecting fluid flow such as viscosity and temperature.

Effect of air in lines.

MECHANICS

The effect of a force in stretching, compressing, bending, twisting and shearing. The Newton unit of force . The joule unit of energy. Moment of a force about a point or an exis. The lever. Principle of moments as applied to plant and equipment. Concept of torque.

The simple machine, movement ratio, force ratio and torque ratio. Efficiency as a ratio of work output to work input.

Simple machine calculations on pulleys, gear, screw, belt, chain drives and gear-boxes, clutch and other operating mechanisms. Work done by a constant The watt unit of power. Simple traction power. Graphical representation of work and power as used in lifting operations.

The relationship between revs per second and peripheral speed with practical applications. Graphical representation of a force. Resultant of two forces acting at a point. Resolution of a force into two components at right angles to each other. Example based on contractors plant and machine.

Simple cases of direct shear, tensile, and compressive stress and strain, offects of length and area of cross section. Safety factor and its calculation.

Friction and its effects, useful and wasteful friction for different materials. Elementary treatment of dry, boundary and fluid friction. Effects of lubrication The S.A.E. system.

The centre of gravity of regular shapes and solids and plain figures.

Introduction to stable and unstable equilibrium.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUSES PART I

ENGINEERING SCIENCE

MATERIALS.

Further treatment of the effects of loads on structural members Quantitative treatment of tension, compression, single and double sheer. Hooke's Law and modulus of elasticity and rigidity. The difference between the elastic and permanent deformation. Introduction to simple moments, treatment limited to simple support beams and cantilevers..

MECHANICS

Effect on ground pressure of size of track or area of tyre in contact.Moment of a force as applied to straight and cranked levers. Qualitative treatment and pictorial representation of the compoundlever and parallel forces. Couples, work done by a variable force energy, and potential energy. Friction torque in

clutches and brakes. Heat generated and power lost in friction. Machines force ratio, movement ratio and mechancial efficiency as applied to the crown wheel and differential axle, screw and hydraulic jack, geared winch and plant mechanisms. Sunple and compound gearing as used in construction plant. Velocity and acceleration, velocity vectors, graphical representation. The action of leaf and coil springs.

FLUID MECHANICS

Pascal's Law; Relationship between pressure, force and area
Pressure head. Flow of fluid through pipes; simple treatment ($q = av$).

LUBRICATION

Properties of a lubricant and their variation with temperature. Viscosity index. Simple treatment of the theory of lubrication. Additives. Oils and greases in common use.

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. Quantitative relationship between pressure, volume, and temperature of a gas $\frac{PV}{T}$ relationship only. The specific heat of a gas under constant pressure and constant volume conditions.

HEAT ENGINE

Cycles of operation; constant volume and constant pressure cycles, their relationship to S.I. and C.I. engines. Testing of S.I. and C.I. engines for torque and brake power. The effect of ambient temperature and barometric pressure on engine output. Faitors governing Volumetric effeciency and power output.

COMBUSTION

The combustion process in C.I. and S.I. engines. Casues and effects of detonation; pre-ignition and diesel knock. Cetane and Octance rating of fuel.

SIMPLE CHEMISTRY

Difference between elements, compounds mixtures and alloys. The distinction between atoms and molecules and between physical
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, hydragen and sulpher. Fuels of S.I. and C.I. engines, their properties and composition, calorific value. Volatility, flash point and specific gravity. Effects of variation in air/fuel ratios on the performance of S.I. and C.I. engines; its side effects on engine components such as valves, cylinder wall, sparks plugs and injectors.

SCIENCE PRACTICAL

Experiment to show relative conductivity of metals.

Experiment to show convection and rediation.

Experiment to show different rates of expansion of different metals.

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

Experiment to determine the melting points of ice, wax and solders and low melting point alloys with observation of thermal and appearance changes.

Experiments on relative densities of liquids and solids.

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

Experiments to show that discharge of water through pipes and orifices various with pressure and pressure head.

Experiments on straight and bell crank levers.

Experiments with a wheel to show relationship between linear and angular speeds.

Experiments on various gearboxes to measure movement ratios, force ratios and torque ratios.

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

Friction experiments to include metal to metal, brake lining to metal, effect or oil film in each case.

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

(At least 12 experiments to be performed each term).

SCIENCE PRACTICAL

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

Boyle' and Charle's law experiments. Experimental determination of swept volume, clearance volume and compression ratio.

Oil vicosity tests of various lubricants, using an orifice type of viscometer.

Specific heat experiments.

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

Testing condensers for capacitance and insulation. Testing the circuits of a coil ignition system adjustable test gaps. Use of a rotating gap to show the effect of the centrifugal advance mechanisms.

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.

Screw jack and simple machine experiments. Tests on a vehicle to ascertain the overhaul 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 four wheels.

Use of dynamometer to determine torque, brake power and brake mean effective pressure.

Specific fuel consumption tests to determine the termal efficiency of both S.I. and C.I. engines.

ELECTRICITY

Electrical units; the volt, ampers and ohm; their relationship; conductors. insulators and resistors.
Series and parallel methods of circuit connection. Fuses their purpose and rating The earth return and insulated return system. Effects of an electric current; heating, chemical and magnetic. Simple qualitative treatment of electro magnetic induction.

LABORATORY

Build up of series and parallel circuits, measuring all voltages and currents. Experiments to show the effects of an electric current.

Cells, primary and secondary. Composition of electrolyte and the variation of specific gravity with the state of charge. Battery capacity; the ampere hour.

Relationship between E.M.F. potential difference, current and resistance in the simple direct current electric circuit. Volts and amperes, their measurement by simple meters.

Use of Ohms' Law; voltage drop in conductors: resistors in series and parallel and determination of effective resistance.

LABORATORY
Experiments on primary and secondary cells. Mixing electrolyte. Proving Ohms Law.

Effect of length, cross-sectional area, material and temperature on a conductors resistance; the relationship between current, voltage and power. Permanent magnets; magnetic field round a conductor; a coil and a solenoid; force acting on a current carrying conductor in a magnetic field.

LABORATORY
Measurement of resistances of various conductors. Experiments involving magnetism i.e. solenoids, coils etc.

Principles of the generator and electric motor (qualitative treatment only).

CONSTRUCTION PLANT TECHNICIANS' PART II

PRIME MOVERS

Three phases of combustion in a C.I. engine, importance of swirl and turbulence. Engines. Combustion chamber shapes including shape of piston crowns in both S.I. and C.I. engines. Piston rings, special types. Crankshaft dampers, action and mounting. Attachment of wheel, timing gear and pulleys. Static and dynamic crankshaft balancing.

Pressure charging, types of superchargers including the turbo charger and use in S.I. and C.I. four and two stroke engines. Testing and checking of superchargers. Starting and shut down procedures.

Fuel injection equipment. Mechanical, hydraulic and pneumatic types of governors. Correct adjustment of pump stops. Distributor type fuel injection

pump, construction, action and operating characteristics. Cold start devices for C.I. engines, heater plugs, decompressors, ether spray. Induction manifold heaters.

Heavy duty starter motors.

Cooling systems pressurised and sealed. Temperature gauges.

Coil ignition systems. Theory of electro magnetic induction. Influence of dwell angle on coil performance.

Clutches. Diaphram spring, multi plate and centrifugal clutches.

Epicyclic gears. Simple treatment on automatic gearboxes and transmission reduction gears.

Constant velocity joints.

Worm and worm wheel final drive, multi drive axles, four wheel drive vehicles.

Lubricants. Specification of oils and greases for special purposes for engines and transmissions. Types of additives and reasons for their use.

Pneumatic and hydraulic power steering systems.

Brakes. Use of booster devices and pressure limiting valves in hydraulic systems.

A.C. generators, their construction and operation. Regulators in use with A.C. generators including transistorised.

CONSTRUCTION PLANT TECHNICIANS' PART II

PRIME MOVERS

Engines Factors affecting the layout of manifolds, induction and exhaust systems and constructional details and theory of operation, including the Rotor type (Wankele silencers).

Operating principles of hydraulic and mechanical systems in automatic gearboxes.

Brakes. Servo assisted brakes, continuous flow hydraulic type, suspended vacuum and vacuum assisted.

Compressed air brakes including detail of components i.e. compressor, receiver, valves and actuators.

Auxilliary brakes, eddy current, hydraulic and exhaust types, fail safe, air braking system, rubber and air suspension systems.

Final drives. Limited slip differentials. Two speed and double reduction rear axles.

CONSTRUCTION PLANT TECHNICIANS' PART II

TECHNOLOGY

PLANT

Crawler tractors, their transmission and steering systems. Track laying gear, types of track, frames, idler sprockets, types of track pad, methods of track adjustments, servicing and maintenance requirements. Conditions affecting choice of track pads.

Hydraulics. Multiple pump circuits as used on plant. Hydraulic drive systems e.g. winches, power take-offs, etc. Commercial testing equipment including flow meters.

Fluid transmission. Multi stage torque convertor. Fluid transmission oil and cooling systems. Hydrostatic drive systems, construction and operation.

Combined front and rear axle steering systems.

Plant vehicles. The constructional features, power transmission, steering and braking systems of loaders, excavators, rollers, scrapers, bulldozers and graders. Blades, buckets and lifting mechanisms.

Articulated and non-articulated trailer couplings. Fifth wheel and automatic arrangement, anti jack knife devices, automatic lubrication systems.

Selection for efficient operation of plant. Practical considerations involved, costs, performance, site conditions, type and size of plant, standardization of plant operated, the work programme. Introduction to soil mechanics as applicable to plant operation.

The constructional features, power train, steering and braking layouts of entrenching machines, asphalt finishers, earth augers, motorised saws, compressors, concrete mixers.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUSES PART II

PRIME MOVERS PRACTICAL

Examining of engine parts 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 crank shaft damper.
Examination of super charges.
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 a cold-starting devices.
Examination of pressurized and sealed cooling systems.
Examination of heavy duty starter motors.
Examination of various clutches,. Adjustment of operating controls where applicable.
Examination of constant velocity joints.
Dismantling of worm and worm wheel final drives, multi-drive axles and four wheel drive transmission systems. Re-assembling with the necessary
Dismantling, examining, rebuilding and adjusting a power assisted steering unit of both the hydraulic and pneumatic types.
Examination of hydraulic brake booster devices and pressure limited valves.
Dismantling examination and assembling A.C. generators. Voltage adjustments where necessary.

Examining manifolds and exhaust systems with special regard to layout and arrangement for efficient functioning.
Internal examination of automatic gear boxes with the practical testing of at least one type.
Dismantling, examing and re-assembling of servo-assisted brake units, power operated brake systems with special reference to servicing of any special equipment required. Inspection of an exhaust braking unit, also Eddy current and hydraulic types.
Examination of rubber, air and liquid suspension units with special reference to servicing of any special equipment required.
Inspection and demonstration of the action of a limited slip differential.
Examination and testing of a transistorized ignition system.

PLANT PRACTICE: (APPLIED PLANT TECHNOLOGY)

Examining hydraulic multiple pump circuits as used on plant.
Dismantling, inspecting and re-assembling the components of these circuits.
Dismantling, inspecting and re-assembling and testing hydraulic drive systems i,e, winches, power take offs etc. Use of commercial testing equipment including flow meters.
Dismantling, inspection and assembling a multi stage torque convertor.
Dismantling, inspection and assembling of a hydrostatic drive system.
Inspection of a front and rear axle steering system.
The dismantling of a complete transmission system on a track type of vehicle.
Inspectionof components for wear, visually and by measurement, re-building of the transmission; alignment of drive sprockets.

Inspection and maintenance procedure. Fault diagnosis and rectification.
Examination, dismantling and assembling of steering and braking systems as used in various plant vehicles.
Machining. Cylinder boring. Crack shaft grinding. Brake drum and brake disc reconditioning. Reconditioning of track running gear.

Examination and maintenance procedures on couplings for articulated and non articulated trailers, anti-jack-knife devices and automatic lubrication systems.
Dismantling and assembling the power train, steering and braking layouts of entrenching machines, a sphalt finishers, earth augers, motorised saws,. compressors, concrete mixers etc.
Routine servicing.
The selection of plant on the work site for efficient operation.

DRAWING AND SKETCHING

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 and pressure angles. Construction of typical cam profile for flat and curved followers.Sketches and drawings related to the work in plant technology with particular reference to layout drawings and secitional views showing main design features, component construction and assembly relating to C.I. engines, fuel injection pumps, injectors and nozzles, dynamos and alternators; steering systems incorporating a power assisted circuit, final drive systems using heavy plant vehicles.

Sketching and drawings of typical plant vehicle layouts.
Hydraulic circuits and hydraulic symbols.
Transmission paths in track laying vehicles, methods of steering the track frame and its components.
Sketches and drawings of special tools, clamping devices, testing equipment to show methods of construction and use; 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 plant vehicles and reciprocating engines and to problems in the balancing of single cylinder and multi cylinder in-line engines.

Sketching and drawing of assemblies and component details to cover the scope of the plant technology syllabus.

MATHEMATICS

Law of logarithms. The idea of base. Transforming system, logs form to index form and vice versa. Change of base – log.
Use of niperian log tables.
Solution of experimental equations.
Log–log graphs ($y = a^{11}x$)
Angles greater than 90°.
Compound angle formulae. Graphs of compound and double angle trig functions.
Period, amplitude Frequency. Phase, Compound waves.
Further quadratic equations. Solution by graphical means.
Further mensuration of cross sections, cone and pyramid.
Arithmetical progression.
Geometrical progression and its applications to gearing.
Arithmetic mean and standard deviation.
Histograms and distribution curves.
Elementary theory of probability.
The use of Binimial expansions for engineering approximations.
Distribution curves. Binomial (and the significance of standard deviation).
Poisson.
Problems in other subjects where a mathematical solution is reuired.
Pappus theorems.
Differentiation of a simple expression such as $y = a^n x$, $y = ax^2 + c$, $y = \sin(ax + b)$; $y = \cos(ax + b)$. Integration as a process of summation and as the reverse of differentiation. General application of differentiation and integration to typical problems encountered in plant technology such as: work done during expansion and compression to the law PV^n = constant; realtion 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 slider-crank-chain mechanism.

ENGINEERING SCIENCE

Mechanics'

Impulse, impulse and momentum. Direct impact. Mechanical energy, potential energy. Kinetic energy. Conservation of energy. Kinetic energy of a rotating mass.

Radius of gyration. Centripetal and centrifugal forces, qualitative application to governors and clutches.

Forces on a vehicle due to acceleration and braking. Problems involved with weight transfer. Quantitative treatment of the relationship between stopping distance and braking efficiency. Rolling resistance, gradient resistance, air resistance, tractive efforts and tractive resistance. Power expressed as a product of force and velocity or torque and angular velocity. Power available and power required. Vibrations and oscillations. Examples from plant applications such as spring oscillations, chassis vibrations and valve operation. Frequency, periodic time and amplitude.

HEAT

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 venting and cooling hydraulic systems. Sensible and latent heat and enthalpy; Vapour pressure of liquids.

HEAT ENGINES

Mechanical equivalent of heat, conversion to mechanical energy and vice versa, lossess involved and efficiency of conversion. Specific fuel consumption and thermal efficiency.

Types of test and methods of testing, dynamometers. Principles and use of high speed engines indicator. Consideration of pressure/volume and pressure/crank angles diagrams.
Effects on the form on the diagram of throttle opening, ignition setting, compression ratio, valve setting, fuel injection pump setting and super charging. Use of the planimeter. Determination of pressure and Indicated Power diagrams. Engine heat losses.

FLUIDS

Fluid and atmpospheric pressure gauges, the barometer. Archimedes principle, the hydrometer. Pressure and velocity, head of a fluid, its potential and Kinetic energy. The flow of a fluid through an orifice.

HYDRAULICS AND LUBRICATION

The movement ratio, force ratio and mechanical efficiency of hydraulic jacks and presses. Hydraulic fluids in brake and hydraulic systems. Action of fluids on natural and synthetic rubber seals. Use of rolling elements to reduce friction in bearing. Lubrication of ball and roller bearings. Pre-lubricated and self lubricated bearings.

ELECTRICAL

Semi conductors. Simple explanation of the functions of the common types of diodes, transistors and zener diodes. Alternators. Armature and field wind-

ing arrangements in typical generators. Rectification of A.C. and D.C. by static rectifier. D.C. generators, armature and field arrangements, brush gear. Regulation of output of generators by field current control by using electro magnectic and solid state regulators.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART II

ENGINEERING SCIENCE

HEAT ENGINES

Consideration of I.C. engine cycles of operation, theoretical and practical; based on the combustion processes; air standard efficiency of an engine; relative efficiency. Practical ranges of air/fuel ratios for S.I. and C.I. engines. Effect of altitude on engine performance.
Storage and handling of fuels.

MECHANICS

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

Problems involving triangle and polygon of forces with reference to structural arrangement of lifting mechanisms also brake shoes and their reaction on the drum. The relationship between pedal effort and braking force for both mechanical and hydraulic operation.

Steering gear torques, direct and reversed efficiencies of operation.

Speed, velocity and displacement, relative velocity, angular velocity in revolutions per minute and radians per second. Velocity vectors. The effect of centrifugal force on the stability of machines and vehicles when on banked and unbanked tracks.

Static and dynamic balancing of rotating and reciprocating parts.
Principle of harmonic balancers and their action.

MATERIALS

Material behavious when subjected to various loads in tension compression and shear forces. The relationship between load, stress, and strain and their effect on plant vehicle members. Moduli of elasticity and rigidity. The elastic limit, modulus of elasticity and ultimate strength when testing materials to destruction. The influence of heat treatment on the properties of steels, light alloys and copper alloys. Hardness test.,

The characteristics of common steels and alloy steels. A brief outline of the physical propertiesand uses of nickel and nickel chrome alloy constructional steels, corrosion resistance steels, non ferrous alloys, magnesium base alloys, alloy and high duty cast irons, cast and wrought aluminium alloys, bearing metals. Hard surfacing materials and their uses. Fatigue in metals, factors affecting fatigue failure, recognition of failures due to figigue.

Strength of materials. Bending moments and sheer force distribution in simply supported and cantilever beams, with relation to plant struction. The resistance to bending of beams of rectangular, circular (solid and hollow) channel and I section, relate to plant struction. Influence of cross section and length on resistance to twist. Critical speed of rotating shafts. Laminated or leaf spring design. Helical spring design. Use of torsional resilience in springs and in shafts subjected to torque fluctuation. Properties and application of glass reinforced Polyster Resin for plant construction.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART II

SCIENCE PRACTICAL

Experiments or demonstrations to show the differential of expansion of related components, such as piston rings and bore gudgeon pin in poston 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 Moss test as a means power and mechanical efficiency.

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

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

Use of a dummy rig to measure the turning moments on the crank shaft for a given load on the piston.

Simple fly wheel experiments to show the energy equation.

Exaperiments using hydraulic jacks.

Measuremont 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 movements.

Engine testing by high speed indicator.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART II

SCIENCE PRACTICAL

Direct measurement of air consumption of S.I. and C.I. engines to determine volumetric efficiency.

The volumetric efficiency as determined from the analysis of the brake mean effective pressure 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 measurement 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 test. 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).

Experiments to show stability of cranes.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART III

WORKSHOP ORGANISATION

Layout and maintenance of premises.
Specialist equipment in the workshop.
Service Tools.
Costing, charging and invoicing.
Work study and operation planning as applied to standard repair schedules and time.
Job control systems.
Wage structures.
Bonus and incentive schemes.
Preventative and planned maintenance.
Repair schedules and servicing plans, service records, pre-delivery and after sales servicing, manufacturers service bulletins and technical instructions, overhaul manuals.
Inserice inspection methods and techniques.
Warranty procedures and handling of claims.
Repair workshop organisation.
Plant accident damages and defect organisation. Plant recovery.
British standards relating to construction plant equipment, design and operation.
Qualifications of staff at all levels.
Obligations to manufacturer.
Insurance policies, excess and no claim bonuses.

PARTS DEPARTMENT AND SALES

Si ting of stores and its layout.
Basic stores documentation and records.
Goods received notes, damage and storage reports, return to stores notes, copy orders, bin cards, stock record cards.
Sales promotion.
Basic consideration of salesmanship.
Personal qualities of a salesman.
Sequence of a sale.
Importance of product knowledge.
Overhead costs, operating costs and profitability.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART III

PRINCIPLES OF MANAGEMENT

INTRODUCTION

The role of the supervisor in the construction plant industry.
Levels of responsibility; significance and scope.
Planning and controlling work.
Personel aspects, safety health and welfare.

INDUSTRIAL RELATIONS

The human factor - problems of change.
Worker and worker. Worker and management. Worker and machine.

Building and maintaining team spirit.
Motivation, discipline, grievences and interviews.
Existing mechanisms for consultation, negotiations and conciliation.
The role and function of the Trade Unions.
Industrial Relation Act.
The role and function of training boards.
Labour utilisation, instruction and training.
Employment Act.

COMMUNICATION

Channels of communication; verbal and written.
Reports, memoranda and letters.

ADMINISTRATION

Authority and responsibility, delegation by communication and involvement. co-ordination and controll of activities.
Man power budgeting, promotion and succession.
Recruitment, selection and training of personel for workshop and office).
The employment of mobile and site based mechanics.
Basic work study techniques and data processing.
Critical path analysis, utilisation of equipment.
Plant control. The role of the computer.
Simple treatment of input, processing and output of a computer installation.
Application of computer techniques to maintainance of plant records and plant management.
Records of machines, depreciation, written down value and investment grant.
Estimated service life.
Profit, cost and utilisation.
Operating costs and overheads. Higher costs.
Hourly cost, variable cost.
Cost of servicing and repairs.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART III

COMMERCIAL PRACTICE

THE OFFICE

Its place as an integral part of a business organisation.
Brief outline of the functions and relationships of the main divisions of the office; purchasing, sales, cashier, accounts, personnel and administration.

ESSENTIAL OFFICE SKILLS

Control of correspondence and filing, storage of information and retrival.
Main types of filing, indexing and maintaining records.
Telephone service and the proper use of the telephone.
Calculations, involving price, percentage applied to buying and selling; turnover, cost, wages, salaries, interest, discount and commission.
Desk calculating machines and Ready Reckoners.

COMMERCIAL TRANSACTIONS AND FINANCIAL ASPECTS

Wholesale and retail price.
Function of wholesaler and retailer.
Trade discounts.
Cash and credit sales.
Documents involved – quotation, order, invoice, credit note, debit note, statement.
Credit facilities and instalment trading.
Books required for entry of credit purchase, sales, cash recording and petty cash.
Function of money; coin, note, legal tender, order, bearer, crossed and un-crossed cheques.
Bankers Drafts and credit transfers.
Bills of exchange, promissory notes.
Postal and money orders.
The types of Banks and the services rendered by them.
Current accounts, deposit accounts, loans, overdrafts,
Bankers orders, travellers cheques, credit cards.
P.A.Y.E. National Insurance, staff records.
The principle advantages and scope of Insurance, e.g. fire, motor, burglary, employer liability and guarantee.

CONSTRUCTION PLANT TECHNICIANS' SYLLABUS PART III

LAW AND LEGISLATION OF PLANT AND TRANSPORT

Regulations affecting the sale of goods under common law.
Contract,agency. Sale of goods act.
Factories act; offices, shops and railway premises act.
Condition of employment. Redundancy payments act. The law of lien.
Disposal of uncollected goods.
Transport act regulations as applicable.
Construction and use regulations.
Road traffic acts.
Light regulations.
Police Tests.
Operation and testing of vehicles.
Trade plate regulations.
Regulations relating to the purchase, road transportation, storage and sale of petrol, oil, paint and other dangerous substances.

THE EAST AFRICAN EXAMINATIONS COUNCIL

REGULATIONS AND SYLLABUSES

280 – 285

MAIN ELECTRICAL INSTALLATON TECHNICIANS' COURSE

THE EAST AFRICAN EXAMINATIONS COUNCIL

REGULATIONS AND SYLLABUSES

280 – 285

MAIN ELECTRICAL INSTALLATON TECHNICIANS' COURSE

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THE COUNCIL AND ITS CONSULTATIVE MACHINERY

1. The Council consists of a Chairman, who is the Vice-Chancellor of one of the Universities of East Africa (the Office is held in rotation for a period of three years), six members appointed by the Senates of the three Universities, three members appointed by each of the three Governments of East Africa, two Heads of Schools from each of the three countries of East Africa, two representatives of the East African Community, and one representative of the University of Cambridge Local Examinations Syndicate.

2. The Technical Examinations Committee:

The Technical Examinations Committee of the Council is responsible for the following:

entry regulations, regulations for award of certificates, forms of certificates awarded by the Council, approval of subjects to be examined, subject syllabuses prepared by International Advisory Committees, appointment of examiners and approval of Technical examination centres.

The Committee consists of a Chairman elected from the members. The Committee membership includes the following:

(a) Three representatives appointed by the three Government partner states,
(b) Three representatives from the Universities of East Africa,
(c) Three Principals or their representatives of the Technical Colleges in East Africa,
(d) Two representatives from the East African Community,
(e) One Director of Industrial Training Board of each Partner State,
(f) One representative of the Federation of Employers from each partner State,
(g) One representative from the East African Institute of Engineers,
(h) The Secretary to the Council.

3. International Advisory Commitees:

The Council has International Advisory Committees to cover every subject or group of subjects examined. Each committee includes appropriate representatives from each country, examiners and professional men. The International Advisory Committees are responsible for drawing up and revising syllabuses and receiving criticisms and suggestions concerning existing syllabuses. They also work closely with the National Advisory Panels which are responsible for devising syllabuses suitable for their respective countries. The Secretary to the Council or his representative is an ex-officio member of each committee.

4. National Advisory Panels:

There are National Advisory Panels in each of the three countries whose function is to advise the Government on the examinations to be made available in the country and to make representations as appropriate to the Council in regard to the examinations and other matters with which the Council is concerned. Each country appoints members to its National Advisory Panels.

CONTENTS

REGULATIONS AND SYLLABUSES

FOR

280/285 – ELECTRICAL INSTALLATION TECHNICIANS' COURSE

Introduction

1. This scheme for courses of study and related examinations is intended for technicians in the electrical contracting and allied industries. It is intended to provide the technical knowledge necessary for a technician who will be employed in planning electrical installations. 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.

Course of Study

2. 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 studies) gives a broad introduction to electrical engineering principles and installation. Part II (about 780 hours of studies) provides for further study in detail of installation technology and related topics. Part III (about 150 hours per subject) provides for advanced study in greater depth of two (or more) of a range of specialized subjects. There is provision for college devised syllabuses to meet local requirements at Part III level (see paragraph 4 below).

3. The subjects of the course are shown below. In Parts I and II time should be devoted to laboratory and practical exercises in support of the theory.

PART I	Mathematics I Engineering Principles Installation Technology I Sketching and Drawing Technical Reports General Studies Electrical Engineering Principles I
PART II	Mathematics II and Mathematical Applications Electrical Installation Technology II Testing Methods (Power) and Reliability Consumer Distribution Systems General Studies
PART III	two of: Estimating and Tendering

Engineering Services Contracts
College syllabus to meet special local requirements.
(See also paras 6 and 22)

4. Information about the submission of college-devised Part III syllabuses can be obtained from the Council.

5. General Studies are regarded as an integral part of the course (see para 1) and the aim should be to allocate about 60 hours for Parts I and II and up to 100 hours where local conditions make this possible. The Council will not examine in General Studies and colleges are free to devise their own syllabuses and approach to the subject. The Council will publish a pamphlet in which an approach to General Studies will be suggested.

6. This scheme has been planned in association with the Electrical Engineering Technicians' Course. The Part I syllabuses in Mathematics and Engineering Principles are common with that scheme and also largeley common with those in the Telecommunication Technicians' Course and the Radio, Television and Electronics Technicians' Course. The Part II subjects of Mathematics, Electrical Principles and Testing Methods (Power) are also common with those in the Electrical Engineering Technicians' Course and a number of the Part III examinations for Electrical Technicians' qualify for the award of the Full Technological Certificate for Electrical Installation Technicians.

Entry to Course

7. The selection of students for the course is within the discretion of the college, but the Council recommends that students should satisfy one of the following conditions or have reached the appropriate standard by alternative route.

(a) PART I

(i) Completion of a secondary school course, including Credit Pass in English, Mathematics and a relevant Science subject or equivalent.
(ii) Completion of the first year of a General Course in Engineering.

(iii) A pass in Electrical Installation Work Course B with a standard in Mathematics satisfactory to the College.

(b) PART II

(i) A pass in the Council's Part I examinations for Electrical Installation Technicians or the corresponding equivalent examination. (See Appendix A).

(ii) Electrical Installation Work Course C with a standard in Mathematics satisfactory to the College.

(c) PART III

(i) A pass in the Council's Part II examination for Electrical Installation Technicians.

(ii) Other equivqlent qualifications provided the college is satisfied that the students are fully conversant with the I.E.E. Regulations.

Approval for Course

8. This scheme is available at those Colleges which have received the Council's approval. Application for approval of a course should be made on Form EAEC/TE/C.1 obtainable from the East African Examinations Council, P. O. Box 7066, Kampala, Uganda.

Examination Regulations – General

9. The Council 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.

10. 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

11. Candidates enter for the Council's examination as either internal or external candidates.

(a) **Internal Candidates**

Internal candidates are those who, at the time of entry to the examination, are undertaking (or have already completed) the course (including, for Part I and Part II, General Studies) at a technical college or other approved establishment.

(b) **External Candidates**

Candidates who have valid reasons for not having attended a course of study may be given permission to enter as external candidates provided that they can satisfy the Council as to their industrial experience and preparation for the examination. External candidates for Part II must have passed Part I (or equivalent – see Appendix A) and external candidates for Part III must have passed Part II (or equivalent – see Appendix A).

Applications must be made on Form EAEC/TE/X which must be received at the Council not less than six months before the date of entry to the examination. External candidates for Part II and Part III Estimating must also apply to the Council for project details (see paras 15 to 18).

Examinations

12. The examinations for Electrical Installation Technicians are listed below.

PART I

280–1–01	Mathematics I	3 hours
280–1–02	Engineering/Electrical Engineering Principles I	3 hours
280–1–04	Installation Technology I	3 hours

For the award of the Part 1 Certificate candidates must obtain an overall pass in the same examination series, in all three papers. See Appendix B for conditions of entry to paper 04 only.

The Installation Technology paper may include questions on the subject matter of the Sketching and Drawing and Technical Reports syllabuses.

PART II

285–2–11	Testing Methods (Power) and Reliability	3 hours
285–2–12	Consumer Distribution Systems	3 hours
285–2–13	Installation Technology (written) II	3 hours
285–2–14	Installation Technology (Project)	40 hours

For the award of Part II Certificates candidates must obtain an overall pass in papers 11 and 12 and in the aggregate of papers 13 and 14. All papers must be taken at the same time, except that success in the project may be carried forward (see para 18). No separate question paper will be set in Mathematics or Electrical Engineering Principles II, but questions set in any part of the examination may involve a knowledge of these syllabuses.

PART III

ESTIMATING AND TENDERING

(Candidates must satisfy the examiners in the aggregate of the two papers).

285–3–21	Estimating and Tendering (written)	3 hours
285–3–22	Estimating and Tendering (Project)	30 hours

ENGINEERING SERVICES CONTRACTS

285–3–23	Engineering Services Contract	3 hours

COLLEGE DEVISED SCHEME

285–9–31	(written)	3 hours

A part III Certificate will be awarded to a candidate who is successful in any one of the subjects listed.

13. Candidates for the Installation Technology paper of Part I (280–1–04) will be required to use copies of the Tables extracted from the 14th Edition of the I.E.E. Regulations (Metric). A booklet containing these tables has been printed for use in examination only, and is available from the Council. In the Installation Technology II (Written 285–2–13), in the Part III papers, and in the projects candidates will require their copy of the 14th Edition of the I.E.E. Regulations (Metric Edition).

14. Draft question papers for college-set examinations must be submitted to the Council by the 31st January for the May-June series and six months in advance of the examination dates for other series.

Projects

15. The Part II Installation Technology Project will be designed to occupy about 40 hours of work, to be undertaken during the course. The written paper in Installation Technology may include a compulsory question relating to the Project.

16. The Part III Estimating and Tendering Project will be designed to occupy about 30 hours of work to be undertaken during the course. The written paper may include a compulsory question relating to the Project.

17. At each level the project will be set by the Council and the project details issued to colleges, 12 months preceeding the examination. Projects will be marked by the Council and be submitted to the Council with examination scripts.

18. A candidate who passes the project at either Part II or Part III level but fails the examination as a whole, may carry forward his success in the project if resitting the examination in a subsequent year. Details of candidates claiming exemption from the project should be forwarded to the Council.

Examination Results and Certificates

19. 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 and in project work.

20. Certificates are awarded to candidates who pass the examination. The certificates indicate the level of examination, i.e. Part I, Part I Supplementary, Part II or Part III as appropriate, and the class of result. In addition, at Part III level the subjects taken will be listed.

Full Technological Certificate

21. The Full Technological Certificate for Electrical Installation Technicians will be awarded to a candidate who:

(a) is aged at least 21 years.

(b) provides evidence of at least 2-3 years of industrial experience in

electrical installation after passing Part III.

(c) holds either

(i) two Part III Electrical Installation Technicians Certificates (one of which may have been based on a college-devised syllabus)

OR

(ii) one Part III Electrical Installation Technicians Certificate (which may have been based on a college-devised syllabus) and one other Certificate recognised by the Council for this purpose (see below)

22. For the purpose of the award of a Full Technological Certificate for Electrical Installation Technicians the Council recognises the following certificates:—

(a) Part III Electrical Engineering Technicians Certificates awarded for the Council's examinations in Generation of Electrical Energy, Transmission and Distribution of Electrical Energy, Instrumentation, Industrial Electronics, Control Systems and Applications.

(b) Advanced Lighting Technology (of the Illuminating Engineering Scheme); Interior and Exterior Lighting Systems.

23. Candidates wishing to apply for the F.T.C. award must write to the Council (Certificate Unit) for the appropriate form EAEC/TE/FTC quoting subject 285—Electrical Installation Technicians' Courses.

APPENDIX A

Entry to Part II courses and examinations.

External candidates for the Part II examination must have passed either

(a) the Part I examination for Electrical Installation Technicians or

(b) the Part I Supplementary Certificate in Installation Technology (or Supplementary Certificate in Installation Work and Regulations of Electrical and Electronic Craft Studies Part II plus one of the following:

Part I Certificate of the Electrical Engineering Technician's Course
Part I Certificate of the Electrical Engineering Technician's Course
Part I Certificate of the Telecommunication Technician's Course
Part I Certificate of the Radio, Television and Electronics Technician's Course
Ordinary National Certificate in Electronical Engineering.

It is recommended that internal candidates should hold one of the above qualifications or a pass in Electrical Installation Work Course C with a satisfactory standard in Mathematics (see para 7 (b) of the regulations) before being admitted to Part II of the course.

Entry to Part III examinations.

External candidates for the Part III examinations must hold either

(a) Part II certificate of the Electrical Installation Technicians Course or

(b) the Installation Work and Regulations paper of Course C (235—1—01) plus one of the following:

Part II certificate of the Electrical Engineering Technicians' Course,
Part II certificate of the Telecommunication Technicians' course
Higher National certificate in Electrical Engineering.

APPENDIX B

Entry to Part I Supplementary paper in Installation Technology

Candidates may enter for paper 280—1—04 Installation Technology as a single paper if they hold one of the following:

Part I Certificate of the Electrical Engineering Technicians' Course
Part I Certificate of the Telecommunication Technicians' Course
Part I Certificate of the Radio, Television and Electronics Technicians' Course
Ordinary National Certificate in Electrical Engineering.

280/285—ELECTRICAL INSTALLATION TECHNICIANS

Note: Safety
It is essential that particular emphasis be placed at all times on safety and safety precautions in the laboratory and workshop. The attention of students should be drawn to the provisions of the Electricity Supply Regulations, The Factories Acts, The Offices, Shops and Railway Premises Act, and the I.E.E. Regulations for the Electrical Equipment of Buildings, and they must be warned of the hazards involved in handling electrical equipment.
Instructions should be given in the safety precautions to be observed before making connections to 'live' mains, or switching on equipment which may be so connected. Students should be made aware of the location and method of operation of isolating switches and other safety devices, and should receive instruction in simple first aid and artificial respiration in cases of electric shock. Posters should be prominantly displayed.
It is not intended that this be treated in a series of formal lectures, but the importance of safety precautions for both personnel and equipment should be continually brought to the notice of all students using the laboratories and workshops.

Part I

Engineering Principles
Throughout this syllabus the S.I. system of units should be used, but there should be frequent reference to the relationships with, and conversion to, other systems in use.

This syllabus is identical with the Engineering Science syllabus in Telecommunication Technicians.

FORCE

1. Revision of definitions and units of mass, force and weight; scalar and vector representation of a force, friction and friction force as 4 times normal reaction. Resultant of two forces acting at a point determined graphically and by taking rectangular components; resolution of a single force into rectangular components, application to simple practical problems. Triangle of forces and extension to polygon of forces, resolution of forces graphically and by resolution into components. Description of the turning effect of a force, unit of torque, calculation of torque for simple practical problems.

WORK, ENERGY AND POWER

2. Unit of work, work done by a force applied (a) along and (b) at an angle to, the line of motion, work done in lifting and against friction, work done by a torque. Power as a rate of doing work, energy; simple treatment of energy of a body by reason of its position and of its motion, loss and gain of energy. Losses: output as input minus losses. Efficiency: definition as output/input, percentage and pre-unit presentation, accuracy of calculation when input and output are approximately equal.

STRESS AND STRAIN

3. Types of simple stress (tensile, compressive and shear). Relationship between stress and strain within the elastic limit; typical load/extension graphs for ductile and brittle materials and their simple physical limitations; simple statement of Young's modules and meaning of safety factor. Simple springs.

LINEAR MOTION

4. Definition of velocity and acceleration, units. Distance-time and velocity-time graphs. Resolution of velocities. Introduction to Newton's Laws of Motion and the relation between force, mass and acceleration, simple problems on practical traction, problems involving lifts, hoists and vehicles. Meaning of inertia of a body.

ANGULAR MOTION

5. Definition of angular velocity and acceleration, units, the relationship between linear and angular velocity. Factors affecting the inertia of a body, descriptive treatment of energy stored; purpose of the flywheel.

MACHINES

6. The function of machines. Definitions of velocity ratio and mechanical advantage and their calculation for simple machines, such as lever, screw-jack and gear train.

HEAT

7. Descriptive treatment of expansion of liquids, and solids, definition of coefficient of linear expansion, applications, e.g., thermometer, bimetal relay, expansion in civil engineering structures, simple thermostats. Simple treatment of transfer of heat by conduction, convection and radiation, practical application such as heat sinks and cooling of equipment.

DIRECT CURRENT CIRCUITS

8. Elementary idea of current: flow; description without units of current, including difference between alternating and direct current; quantity of electricity as number of static or motional charges; impedance as resistance or opposition to current flow; difference between conductors, semi-conductors, resistors (including idea of non-linear resistor) and insulators; electromotive force as 'driving voltage' produced by a source; potential difference as voltage required to force current through resistance; capacitance as charge per unit potential difference. Energy as heat energy produced by current flow through resistance; simple idea of potential energy of stored charge. Power as rate of doing work; units of current, quantity, voltage (energy/unit charge) and resistance; Ohm's Law. Electro-chemical effects; chemical effect of a current. Faraday's Law of electrolysis and application; corrosion. Primary cells, Secondary cells; lead-acid and alkaline cells (non-chemical descriptions), characteristics, internal resistance. Series and parallel connection of cells. Principles of charging methods. Basic maintenance. Resistors in series and parallel; relationship between resistance and conductor dimensions and dependence on material, resistivity (dimensions, e.g., ohm-metre as resistance-length); conductivity as reciprocal of resistivity and d.c. conductance as reciprocal of d.c. resistance. Effect of temperature on resistance (introduced graphically), temperature coefficient of resistance referred to any base temperature.

MAGNETISM AND ELECTROMAGNETISM

9. Permanent magnets, field distribution for common arrangements. Magnetic effect of a current; description of field produced by a straight conductor, two parallel conductors and a coil. Concepts of a magnetic field, flux and flux density. Force on a current carrying conductor in a field as B.I.l.) and hence definition of units of flux density and flux; practical application of this force such as motor and moving-coil meter and blow-out coil. Idea of force between parallel conductor and turns of a coil with practical applications: but no calculations (other than by use of definition of unit current). Induced e.m.f. in moving and stationary circuits; practical applications such as generator principle (with field or conductor moved); Faraday's Law of electromagnetic induction, Lenz's Law. Mutual and self induction. Generation of an alternating e.m.f. by the rotation of a coil in a uniform magnetic field. Flow of alternating current in a pure resistor.

INSTRUMENTS

10. The use of ammeters and voltmeters. The effect of instrument resistance on circuit conditions. Shunts and multipliers.

Electrical Engineering Principles I

This syllabus is identical with the Part I Mathematics syllabus in Telecommunication Technicians.

CIRCUIT THEORY

1. More advanced direct current circuit problems on the parallel circuit, the series-parallel circuit, Kirchhoff's Law and Superposition principle applied to simple series-paralle circuits. Electrical power and energy units and relationship with mechanical and thermal units. Calculations on power and energy dissipated in simple series and parallel circuits. Heating effect of a current, Joule's equivalent in terms of electrical quantities. Examples of methods of transfer of power and energy in different forms including

simple calculations and efficiency of conversion. Simple problems on cost of energy.

This syllabus is identical with the Engineering Science syllabus in Telecommunication Technicians.

ELECTROMAGNETISM

2. The magnetic circuit, magneto-motive force, magnetizing force, permeability and reluctance (a parallel should be drawn between these and equivalent quantities in the electric circuit), the dependence of relative permeability on field strength and flux density, description of magnetization curve and hysteresis loop, idea that energy loss is associated with the loop but no calculations. Magnetic circuit calculations for series circuits using magnetization curve or ampere-turn method of solution excluding leakage and fringing. Induced e.m.f., direction magnitude determined from rate of change of flux linkage. Description of effects of self and mutual inductance direction of induced e.m.f., calculation of e.m.f. of self and mutual inductance from rate of change of flux linkage or rate of change of current; unit of self and mutual inductance. Statement of energy stored in an inductor as ½ LI^2 joules. Practical applications such as ignition system, transformer, etc.

ELECTRIC FIELD

3. Flux and flux density (a parallel to be drawn with magnetic and electric circuit). Demonstration of storage of charge, relationship between charge and applied voltage and hence definition of unit of capacitance. Statement of energy stored in a charged capacitor as ½ CV^2 joules. Examples of construction of fixed and variable capacitors. Capacitors in series and parallel and hence relationship between capacitance and dimensions. Permittivity. Capacitance of the parallel plate capacitor. Introduction to potential gradient and dielectric.

ALTERNATING CURRENTS

4. Generation of e.m.f. in a single coil. Definition of cycle, period and frequency. Reason for use of sine wave; half wave average, peak and r.m.s. values by graphical means, form and peak factors. Meaning of phase and magnitude (amplitude). Waveform plotting from rotating vector, addition and subtraction of sine waves, resultant wave, effect of phase shift, use of phasors (vectors) for addition and subtraction; comparison of resultant with that obtained by plotting waves. Effect of resistance, inductance and capacitance considered separately. Behaviour of pure inductance and pure capacitance only in series. Power in a.c. circuits, unity and zero power factor only.

MEASUREMENTS AND INSTRUMENTS

5. Essential features of an indicating instrument, i.e., devices for deflecting controlling and damping. List of instruments in general use and their applications. Simple descriptive treatment of operation of moving coil and moving iron instruments. Calculation of value of shunts and multipliers. Measurement of resistance by ammeter-voltmeter method (including allowance for effect of introduction of instruments) and by substitution. Principle and application of the Wheatstone bridge. Principle of the simple d.c. potentiometer, standardizing, application to measurement of potential difference, current and resistance.

ELECTRONICS

6. Elementary qualitative treatment of the theory of semi-conductors. The p-n junction. Thermionic emission. The simple diode; space charge; saturation; rectifying action. Types of rectifier, their characteristics and principles of operation. Single-phase, half-wave, full-wave and bridge connections. Smoothing circuits. Comparison of input and output waveforms.

EITHER

(This section for Telecommunication Technicians only).

7. The transistor: input and output characteristics and current gain in common-base and common-emitter configurations. The triode; static characteristics and parameters and their determination. The amplifying action of the transistor and of the thermionic triode with a pure resistance load. Use of load lines. Rectifier and thermocouple instruments for the measurement of current and voltage at audio and radio frequencies. Principles of operation of electromagnetic loudspeakers and microphones.

OR

(This section for Electrical Engineering Technicians and Electrical Installation Technicians.)

MACHINES

8. Essential feature of a d.c. machine. Methods of connection of field circuits. Descriptive treatment of operation of motor and generator. Need for starter and description of d.c. face-plate starter. Essential features of an alternator, (e.g., need for d.c. field system, armature, slip-rings etc)., simple descriptive comparison of rotating and stationary fields and of salient pole and cylindrical rotors, synchronous speed.

CIRCUITS

9. Series or parallel combinations of resistance, inductance and capacitance, with constant supply conditions. [Treatment can be graphical or by calculation (resolving) but should be simple and the parallel case should be restricted to two branches. There should be copious use of phasor (vector) diagrams and it is not intended that symbolic notation should be used.] Power and power-factor; meaning of active and reactive components of current, meaning of volt-ampere, volt-ampere reactive and watt.

Mathematics I

This syllabus is identical with the Part I Mathematics syllabus in Telecommunication Technicians.

General Notes: 1. It is important that maximum time should be spent by students in working out a wide range of examples.
2. Every effort should be made to relate mathematical principles and topics to other course subjects. Experiments and demonstrations should be made to emphasize the use of Mathematics.

ARITHMETIC

1. Conversion of weights and measures from British to metric systems; practice in making approximate conversions. Use of simple conversion graphs for this purpose. Introduction to and the use of algebraic symbols in addition, subtraction, multiplication and division processes and in the addition and subtraction of simple fractions.

DIRECT PROPORTION

2. With special reference to

   (a) volumes of solids and their weights,

   (b) variation in extension and compression of a spring by application of different forces,

   (c) Circumferences of circles and their radii. Calculation of circumferential speeds of rotating wheels and of simple gear ratios,

   (d) percentage and per-unit values.

AIDS TO CALCULATIONS

3. Approximate calculations, their use generally and in particular when using a slide rule. The meaning of a logarithm and the use of logarithmic tables for multiplication and division. Use of tables for squares, square roots and reciprocals. Appreciation of error; simple practical examples, e.g., limitations of instruments; need for use of significant figures.
   Standard form and its use in dealing with unwieldy numbers, e.g., $2240 = 2.24 \times 10^3$; $0.00427 = 4.27 \times 10^{-3}$.
   Construction of the slide-rule. Comparison of results obtained by slide-rule with those obtained by logarithms, during the solution of examples involving multiplication and division processes. Further use of the slide-rule for obtaining squares and square roots; comparison with results obtained from tables.

ALGEBRA

4. Simple algebraic processes. Emphasis on the use of symbols in common use. The insertion and removal of various forms of brackets, e.g., $3 \times [a-2a(1-p)]$.
   Simple factors and their uses in simplifying algebraic fractions, e.g.,

   $a^2-b2 = (a+b)(a-b)$; $x + 1 = x(1 + \frac{1}{x})$.

   Addition, subtraction and multiplication of algebraic fractions, e.g.,

   $\frac{3}{x} - \frac{3}{5x} + 2$; $\frac{p^2q-pq^2}{3pq}$; $\frac{3}{2m} \times \frac{5m^2}{4}$

   Indices and their laws. Positive and negative whole number powers. Powers of ten; common logarithms.

GRAPHS

5. Plotting of graphs from equations of the forms $y = mx + c$ and $y = \frac{1}{x}$.

   Plotting of graphs from experimental results; obtaining information from graphs.

   Determination of the law from a straight line graph; meaning of the slope and the intercept.
   The advantages and limitations of graphical presentation.

FORMULAE

6. Formation and solution of simple linear equations. Transposition of simple formulae, e.g.,

   $R = \frac{\rho . l}{a}$; $v = u + ft$;

   Evaluation of formular using practical values. Linear simultaneous equations in 2 unknowns.

MENSURATION

7. Mensuration of rectangle, triangle, circle, cone, cylinder and sphere. Practical examples in engineering.

GEOMETRY

8. Properties of parallel lines. Types of triangles, sum of the angles of a triangle; similar triangles.
   The Theorem of Pythagoras and its applications.

TRIGONOMETRY

9. Trigonometrical ratios from 0° to 90° (sine, cosine and tangent); particular reference to triangles having angles of 30°, 60° and 90° and of 45° and 90°. Use of trigonometrical tables. Solution of right-angled triangles; verification by scale drawings. Graphical representation of $y = \sin\theta$ and $y = a \cos\theta$ for angles 0° to 360° by projection from a rotating phasor.
   Sine, cosine and tangent of angles of any magnitude; graphical appreciation of these ratios. Circular measure: the radian. The relationship $\sin\theta = \tan\theta$; $\sin^2\theta + \cos^2\theta = 1$. Simple problems involving these relationships. Definition of cosecant, secant and cotangent. Further work involving the graphs of $y = A \sin\phi$ and $y = A \cos\theta$. Plotting and sketching of sinusoidal functions with variation of magnitude and phase; relationship between angular and time scales. Graphical addition of sine waves of differing magnitude and phase.

VECTORS

10. Resultants obtained by Pythagoras' Theorem, by simple trigonometry and by resolution of vectors. Application of phasors (vectors) in the solution of electrical problems.

ALGEBRA

11. Further work on indices, fractional powers with positive and negative values. Manipulation of algebraic expression, such as

    $I = a\,d^n$; $\sqrt[3]{a^2b^4} \div \sqrt{\frac{a}{b^3}}$

$$\frac{1}{m+n} - \frac{1}{m-n} + \frac{1}{m^2+2mn+n^2}$$

The formation and solution of simultaneous equations involving two unknowns. Simple electrical circuit problems. The formation of quadratic equations and their solution by factors and by the use of formulae (without proof). Practical problems involving quadratic equations, e.g., $P = VI$

GRAPHS

12. Graphical solution of simultaneous and quadratic equations. Determination of laws of the form $y = ax^n$; the effect on the shape of the graph of varying a and n. Solution by conversion to straight line form by the use of logarithmic paper.

GEOMETRY

13. The solution of triangles by sine and cosine rules: the area of any triangle. Problems on heights and distances. Chord, angle and tangent properties of the circle, without proof. Principle of the centering gauge; marking out exercises involving the lengths and heights of arcs. The mid-ordinate rule; the determination of the areas of irregular figures; average value and r.m.s. value of alternating current waveforms. The areas and volumes of spheres, cylinders and cones.

FURTHER AIDS TO CALCULATION

14. Use of the slide-rule and tables for more advanced problems; checking by appropriate calculations. The use of logarithms to bases other than ten, e.g., two; the binary notation of numbers. Use of calculating machines.

Installation Technology 1

Note: The content of the syllabuses in Installation Technology is intended to be such that students become thoroughly familiar with the current 'Regulations for Electrical Equipment of Buildings' issued by the Institution of Electrical Engineers, and acquire the knowledge needed for the satisfactory understanding and interpretation of them. Because the syllabus is intended for Installation Technicians and not Craftsmen students should do sufficient practical work to enable them to understand the problems involved in designing Electrical Installations to suit different environments and to supervise the Craftsmen required to carry out the installation. The physical properties of various materials used for conduits, fittings, accessories, cables and flexible cords should be studied concurrently with their use in electrical installation. The importance of the variation of the physical properties of the material with the variation in environment should be stressed, e.g., temperature, humidity, fumes.

1. Introduction to the basic function and requirements of an electrical installation. Simple description of the electrical supply system; Grid and Super-Grid and associated power station; control centres; sub-stations; bulk supply and distribution. D.C. and a.c. systems, single and three-phase systems: the advantage of the a.c. three-phase system; 3-wire and 4-wire distribution systems.

2. The necessity for regulations and safety of life and property. Introductory paragraphs, definitions and Part I of the I.E.E. Regulations. The effect of the Electricity (Factory Act) Special Regulations—1908 and 1944 on Electrical Installation Work. Recommended supply voltage for domestic installations and for hazardous situations (for portable and garden tools). Procedure in the case of electrical shock, artificial respiration.

3. Detailed study of Part II, the tables and appendices of the I.E.E. Regulations for the Electrical Equipment of Buildings with respect to the following types of installation, domestic, offices, schools and industrial.

4. Systems of distribution within the consumers installation. Rising and ring mains. Balancing of single-phase loads on 3-phase systems. Distribution boards for power and lighting circuits. Earthed concentric wiring Protection; fuses, miniature and moulded circuit breakers, excess-current protection coarse and close protection.

5. General layout of lighting and power circuits including radial and ring circuits and busbar arrangements. Description and use of p.v.c., mineral and rubber insulated cables, plain and sheathed cables, flexible cords and cables. Various types of rigid and flexible conduits including light and heavy gauge steel, aluminium and non-metallic types. The need for and use of trunking, risers and ducting. Fittings, accessories, conduit and trunking. Bell and call circuits including indicators; associated transformer-operated systems.

6. General appreciation of installations requiring special consideration, e.g. outdoor installations, systems subject to extremes of temperature and other industrial hazards.

7. The physical properties of metals and insulating materials used in electrical installations and associated equipment. Application to cables, conduit etc. Causes and prevention of corrosion. Effect of temperature and humidity.

8. Metal jointing by soldering, crimping and brazing, solders and spelter; precautions to be taken with electrical connections. Jointing of metals and insulating materials; welding; nuts, bolts and rivets; adhesives. Wall and floor fixing screws, bolts, saddles etc. Cable joints and terminations.

9. Description, use and jointing of mains and distribution cables, including paper-insulated, for medium voltages.

10. Installation and maintenance of secondary cells; lead-acid, alkaline and zinc-air cells; charging devices and circuits. Secondary and emergency lighting systems. Earthing systems; earth-loop impedance, current and voltage-operated earth-leakage circuit-breakers, method of testing.

11. Insulation, continuity and polarity tests on an installation. Use of insula-

tion and conductivity meters, simple fault diagnosis.

12. Behaviour and uses of different types of a.c. motors and generators. Simple theory of a.c. and induction motors. Starting methods and circuit diagrams. KVA rating of a.c. plant, power factor; use of capacitors to improve power factor. Types of domestic water and space heaters, installation and control.

13. Preparation of requisitions for wiring materials required for an installation. Correct nomenclature.

14. Lighting. The meaning of the candela, the lumen and the lux. Simple calculations involving the inverse square law and cosine law. Types of incandescent and discharge lamps, including the ratings of light output and efficiency. Circuitry and principles of operation.

SKETCHING AND DRAWING

Note: Particular attention should be paid to sketching. At the end of the course students should be able to make intelligible dimensioned freehand sketches on squared paper and to read drawings normally encountered in electrical installation work. Drawings should be dimensioned in British or metric units.
Introduction to orthographic projection and scale drawing. Freehand sketching including dimensioning of components such as switches, fuses, distribution boards, brackets, screw threads and types of screws and bolts, including dimensioning and lettering. Drawing and sketching of distribution panels, frameworks and equipment layout. Interpretation of simple engineering drawings and architect's plans and layouts. Preparation of 'as fitted' and record drawings. Drawing of wiring and circuit diagrams. The use of B.S. graphical symbols (appendix 8 of the I.E.E. Regulations for the Electrical Equipment of Buildings). Block, schematic and sequence diagrams. Freehand sketching of single and multiple sine waves of different phase and frequency.

TECHNICAL REPORTS

Note: It is important that a technician should be capable for communicating efficiently with technologists and with craftsmen, and in order to develop such skill he must undertake a serious study of various methods of communication. The following broad syllabus has been prepared for technical reports.

1. The understanding of the current I.E.E. Regulations for Electrical Equipment of Buildings is important to Electrical Installation Technicians and they should be used freely in exercises chosen to illustrate the syllabus content.
2. Different methods of communication, the use of the spoken word, participation in lectures, debates and discussions. The written word, note taking and the expansion of notes to form a report; letter-writing. Summarizing and indexing, preparation of precis. Use of tables, graphs and charts in reports. Comprehension and interpretation of the I.E.E. Regulations for the Electrical Equipment of Buildings; Codes of Practice; Factory Acts, etc.
3. Each student to prepare a 1,500-2,000 word report involving the use of library, catalogues, etc.

Part II

Electrical Engineering Principles II

D.C. MACHINES

1. Introduction to d.c. machine as an energy converter by reference to previous work on production of e.m.f. by movement of conductor in a magnetic field (e = B.l.v.) and force on a current carrying conductor in a magnetic field (F = B.I.l.). The need for a commutating device to ensure uni-directional output or a reversal of current direction: only very simple constructional details to be considered. Mode of operation of the machine, depending upon the direction of the armature current and its relation to the direction of electro-mechanical energy conversion. $V = E + I_a R_a$ related to the direction of armature current. Equation for generated e.m.f., the effects of lap or wave armature winding on the magnitude of e.m.f. and armature current. (Developed armature winding diagrams are not required.) Equation for motor torque. Field circuit connections and associated machine characteristics (developed from Lano and Taola): shunt and compound generators, self-excitation and causes of failure to excite; shunt, series and compound motors. Control of generated e.m.f. by field resistance. Simple control of speed by field and armature circuit resistance variation and by armature voltage variation.

NETWORK THEOREMS

2. Concept of constant voltage and constant current sources. The theorems of Maxwell, Thevenin and Norton and their use in resolving resistive networks into their simplest equivalent from. Maximum power transfer theorem (resistive components only); matching of load to source using transformers. Concept of input and output resistance.

ALTERNATING CURRENT CIRCUITS

3. Series and parallel circuits; power and power-factor. Simple treatment of effects of frequency variation on inductive and capacitative reactance and hence the change of impedance, power and power-factor of a series R,L,C, circuit. Impure components, loss angle and relationship between loss angle and power-factor. Series resonance with constant frequency variable reactance and constant inductance/capacitance with variable frequency; current/frequency curve, effect of variation of resistance; voltages developed across components; Q-factor. Resonance of a parallel circuit with L and R in one branch and C only in the other. (Note: Phasor diagrams supported by trigonometrical and graphical methods should be used for the solution of problems, particular attention being given to the in-phase and quadrature components of the current.) Power-factor improvement using static capacitors.

D.C. TRANSIENTS

4. Growth and decay of voltage in resistance-capacitance circuits; time constant. Growth and decay of current in resistance-inductance circuits; time constant. Students will not be expected to reproduce proofs of

derivation of formulae.

THREE-PHASE SUPPLY

5. Nature of a 3-phase supply and its use in generation, transmission and distribution. Star and delta connection of a voltage source and of a balanced load; phase and magnitude relationships for line and phase current and voltage. 3-phase, 3-wire and 3-phase, 4-wire systems. Calculation of power in balanced 3-phase systems.

TRANSFORMERS

6. Single-phase transformer: essential features of construction. Operation on no-load, considering primary winding only and treating it as a reactor; phasor diagram for this condition. Expressions for induced e.m.f.'s in primary and secondary windings respectively; voltage per turn; voltage, current and turns ratios. Nature and effect of iron losses and methods of minimizing these losses; efficiency. Effects of secondary loading on primary current and power-factor; simple phasor diagram.

INSTRUMENTS AND MEASUREMENTS

7. The electro-dynamic instrument; basic construction and operation as a wattmeter. Alternative wattmeter connections in a single-phase circuit and corrections to be applied. Instrument grades and expected errors. Choice of instrument. Use of instrument transformers to extend the range: methods of connection. Appreciation and use of multi-range and multi-purpose instruments. Simple treatment of principles of operation of cathode-ray tube and use for visual demonstration of voltage and current. Resistance measurement; revision of principle of Wheatstone bridge, use of a commercial d.c. potentiometer and its applications. Construction and operation of ohm-meter; insulation resistance and continuity tester.

TYPES OF AMPLIFIER

8. Function, application and specification of voltage and power amplifiers of the following types: low frequency, wide-band, d.c. tuned, thermionic, solid-state, magnetic and rotating (precise details are not required).

Mathematics II

ALGEBRA

1. Further work on factors, indices, simplification of fractions and transposition of formulae. The formulation and solution of simultaneous equations involving more than two unknowns, e.g., electrical circuit networks containing several branches of meshes. Logarithmic equations: their formation and use. Natural logarithms. The relationship between natural logarithms and common logarithms. The graphical representation of e^{-x} and e^{x}. Application to practical problems.

TRIGONOMETRY

2. Further work on ratios of angles of any magnitude; checking by reference to sketches of the functions; applications to electrical problems. Graphical and mathematical representation of a cosine wave as a displaced sine wave. Summation of e.m.f.'s acting in an electrical circuit by the use of the identity $a \sin 0 + b \cos 0 = r \sin 0 + a$: checking by use of resonably accurate Sketches. Vector and graphical addition of sine waves of differing magnitude and phase. The identities of $\sec^2\theta = 1+\tan^2\theta$ and $\operatorname{cosec}^2 A = 1+\cot^2 A$ and their applications. The expansion of $\sin(A \pm B)$, $\cos(A \pm B)$, $\tan(A \pm B)$. The double angle formulae, $\sin^2\theta = \frac{1}{2}(1-\cos 2\theta)$ and $\cos^2\theta = \frac{1}{2}(1+\cos 2\theta)$. Simple trigonometrical equations and multiple solutions where appropriate.

GRAPHS

3. The plotting and sketching of more difficult trigonometrical functions, e.g. $y = \tan\theta$ $y = a \sin n\theta$, $y = a \cos n\theta$.

   $y = a\mathrm{Cos}(2\theta + \alpha)$, $i = I S$

   Plotting of growth and decay curves.

DIFFERENTIATION

4. Graphical consideration of rates of change. Slope at a point on a curve. Practical applications such as velocity, acceleration and induced e.m.f.'s as rates of change. Differentiation by first principles of simple expressions, e.g. $y = 2x + 3$, $z = 3q^2$. Differentiation of ax^n by rule. Differential coefficients of $\sin\theta$, $\cos\theta$, e^{kx} and $\ln x$. Differentiation of expressions involving products and quotients. Introduction to problems involving maximum and minimum values with discrimination graphically or by consideration of 2nd differential coefficient. Practical examples.

INTEGRATION

5. The reverse process of differentiation and its application to functions of the form $ax + b$, ax^n, $\frac{1}{x}$, e^{kx}, $\sin\theta$ $\cos\theta$, $\sin 2\theta$. The significance of the constant of integration in practical problems involving, for example, velocity and acceleration. The definite integral. The use Integration for determining the area under a curve and the r.m.s. value of a sine wave. Comparison with results obtained by use of the mid-ordinate rule.

Installation Technology II

Note: Reference should be made throughout to the current I.E.E. Regulations and to relevant Codes of Practice.

CABLES AND BUSBARS

1. Comparison in detail of copper and aluminium conductors for cables and busbars including economic considerations. Rating of cables and busbars: effects of voltage-drop, temperature, grouping coarse and close protection. Installation and termination of cables up to and including 11kV and of medium-voltage overhead lines.

ELECTRICAL MACHINES AND APPARATUS

2. Selection of correct equipment, foundation plans, mounting and lining up of machines. Types of enclosure. Methods of starting and speed control of induction, synchronous and a.c. commutator motors. Ward Leonard speed control. Application and control of mercury arc and semi-conductor

rectifiers.

LIGHTING

3. A comprehensive study of the electric light sources available. Planning and design of lighting schemes for internal and external application. Lighting, fittings and polar curves. Point source calculations, inverse square law, cosine law. Luminous flux method, coefficient of utilisation, depreciation and absorption factors. I.E.S. glare index.

HEATING

4. Planning of space and water heating schemes using all types of electrical heating. Calculation of heat losses and power required. Comparison with other forms of heating including economic considerations.

CONTROL SYSTEMS

5. Appreciation of open and closed loop systems; simple applications, e.g., central heating and air-conditioning systems.

TESTING

6. Tracing and remedying of faults in installations, cables, machines and associated equipment. Reporting on installation condition. Test certificates. High-voltage testing of cables and equipment. Commissioning of plant.

TARIFFS

7. Consideration of types in common use. Choice of most advantageous tariff for an installation.

SPECIAL INSTALLATIONS

8. (i) in explosive or hazardous situations.
   (ii) farm and horticultural installations
   (iii) fire alarm systems including fire detection systems
   (iv) temporary installations and installations on construction sites
   (v) caravan sites and caravan installations
   (vi) standby sources of supply and their automatic operation.

LIGHTNING PROTECTION

9. Protection of buildings; bonding and earthing arrangements for protective systems.

CORROSION

10. Causes of and protection against corrosion. Cathodic protection; design and installation of systems.

MAINTENANCE

11. Installation design aspects in relation to maintenance; accessibility; planning and economics of scheduled maintenance.

PLANNING

12. Programme requirements including contractual obligations. Critical path analysis and barcharts. Integration with other trades. Phased delivery of materials to site. Programming of labour requirements.

ESTIMATING AND TENDERING

13. Take-off and pricing of materials, plant and labour for an installation. Calculation of labour rate for a given site and for a particular set of circumstances. Contracts and sub-contracts in common use including R.I.B.A., I.E.E./MECH.E., C.C.C./WORKS/1.

SAFETY

14. Industrial safety. Safety on sites, legal obligations (see 'Supervisor's Guide to the Construction Regulations' published by Ro.S.P.A.). Accident prevention. Methods of dealing with and reporting site accidents.

SITE ADMINISTRATION

15. Labour relations including a working knowledge of the National Working Rule Agreement; statutory health and welfare regulations. Specifications, drawings and bills of quantities. Dayworks and variations, methods of recording and pricing. Increased costs and site instructions. Valuation for interim payments. Preparation of final accounts for installations. Records and 'as fitted' drawings.

Mathematical Applications

Note: This syllabus is for guidance only. It is not expected that students will cover all parts of the syllabus. In determining the sections to be covered or emphasized, consideration may be given to local industrial requirements.

ELECTRICAL NETWORKS

1. Formation of equations involving circulating currents and Kirchhoff's laws; solution of such equations in three or more unknowns, e.g., T and Π networks.

EXPONENTIAL VARIATIONS

2. Sketching and plotting of functions such as
   $Y = 1 - e^{-x}$, $y = Ae^{kt}$, $v = Ve^{-t/CR}$.
   Solution of simple practical problems, e.g., the rise and fall of current in inductive and capacitive circuits and the rise and fall of temperature in electrical equipment. Time constants, their meaning, determination and use.

MAXIMUM AND MINIMUM VALUES

3. Simple practical problems, e.g., maximum efficiency conditions for plant. Economic considerations, e.g. Kelvin's Law.

AIDS TO CALCULATION AND DATA PRESENTATION

4. Use of simple calculating machines. Introduction to simple computer programming and machine control. Use and explanation of simple integrating and differentiating circuits.

FINANCIAL AND COMMERCIAL CONSIDERATIONS

5. Financial records: day books for purchase and sales; cash book; journal; petty cash payment records; ledger accounts of purchase and sales. (Interpretation of a balance sheet.) Profit and loss account and trading account. Factors affecting cash flow and liquidity. Cost accounts: basic principles and relationship to financial accounts. Significance of ratios, e.g., profit

to capital employed, profit to turnover.

Testing Methods and Reliability

This syllabus is identical with the Part II Testing Methods syllabus of the Electrical Technicians' Course.

1. The need for testing. The purpose of Specifications. British Standard Specifications, their aims and uses. Tests to verify consistency of performance and continued satisfactory functioning under specified environmental conditions. Testing of prototypes, small and large batch items. The relationship between testing, inspection, quality and reliability.

2. Testing techniques. Recording, tabulation, interpretation and analysis of results. Estimation of experimental error.

3. Instruments. Review of the applications and limitations of electrical indicating instruments; moving-coil, moving-iron, rectifier, thermal, electro-dynamic, valve-voltmeter, digital display, multi-range and multi-purpose indicating instruments. Distinction between instrument types, e.g., industrial and precision portable and switchboard. Sources of error: shunts and multipliers, the effect of frequency and waveform, the correct choice of instrument. Review of simple precautions to be observed before taking readings, e.g., zero-setting, instrument position, scale factors, checking for mechanical faults. Calibration of ammeter, voltmeter and wattmeter against precision grade instruments (note B.S.89 recommendations). The preparation of correction curves and calibration records.

4. Measurements. Review of the measurement of low, medium and high resistance, including insulation resistance. Accuracy: factors affecting the choice of indicating, comparison and null methods of resistance measurement under d.c. conditions. Checking of inductance and capacitance values using simple four-arm a.c. bridges constructed from readily available components in the Maxwell or De Sauty configurations. Factors affecting choice of detector. Setting up and use of a commercial bridge. Miniature a.c. and d.c. motor testing: use in instrumentation and control systems.

5. Logarithmic units. Bel and Decibel. The decibel as defined in B.S.204 (1960). Use of logarithmic units: logarithmic calibration of instrument scales and controls. Use of logarithmic and polar graph paper.

6. Reliability. Importance of Reliability. System complexity, risks inherent in failures. Definitions. Reliability: mean time to failure; mean time between failures. Types of failure: inherent weakness; misuse; sudden gradual, partial, complete, catastrophic and degradation failures. Periods of failure: early, constant and wear-out failure periods. The bath tub diagram. Conditions of use. Effects of vibration, exposure, etc., in the application situation environmental humidity and temperature; assessment of reliability required; professional and non-professional applications. Distribution and sampling techniques. Elementary descriptive treatment of data handling: averages; standard deviation. Normal and Poisson distributions. Sampling: Confidence limits. Reliability expressed in the form $R_L = e^{-t/m}$. Installation. Effects of installation faults on reliability. Operability. Failures due to incorrect operation; basic concepts in the best presentation of information and correct positioning of controls. Maintainability. Definition; importance of high availability; basic concepts of good maintainability. Operational failures. Importance of accurate interpretation and reporting. Cost. Relationship between reliability and cost; concept of total cost.

7. Measurement of single-phase power, choice of alternative wattmeter connections, allowance for current and voltage coil losses. Extension of instrument range by use of current and voltage transformers. Precautions to be observed.

8. The measurement of electrical power, reactive volt amperes and energy using the induction type instrument, extension of range. Accuracy check on watt-hour meter using wattmeter, stop watch and phase-shifter. Determination of inductance and capacitance by measurement of watts and volt-amperes. The measurement of power and reactive volt-emperes in 3-phase, 3-wire and 4-wire circuits with balanced and unbalanced loads. Frequency measurement using modern frequency meters, C.R.O., or C.R.O. with l.f. signal generator. Testing of synchroscopes, power-factor and phase-angle indicators.

9. Speed measurement by revolution counter and stop watch, tachometer and tachogenerator. The stroboscopic principle and its use in speed measurement. The commercial stroboscope. Comparison of methods and of accuracy. Measurement of high speeds, e.g., of very small fractional h.p. motors used in servo-mechanisms.

10. Temperature rise testing. Comparison of methods using thermo-couple, change of winding resistance, mercury-in-glass thermometer. Embedded sensing elements. Effect of siting of sensing elements on accuracy of results.

11. Tests to obtain the overall efficiency of d.c. motor and generator, transformer and induction motor. Torque-slip curves of induction motor by brake test.

12. Recommended mechanical and electrical tests to be made on suspect equipment before connecting to supply. The C.R.O. and its use to display waveforms for voltage measurements and as a bridge detector; photographic recording.

13. Simple valve and transistor tests using commercial testing equipment. Elementary testing of simple valve and transistor amplifiers. Simple fault-finding. Measurement of voltage and power gain. Use of l.f. signal generator and valve-voltmeter.

14. Earth continuity and bonding tests to determine the effectiveness of the earth connection. Simple fault location.

Consumer Distribution Systems

HIGH VOLTAGE SWITCHGEAR (up to and including 11kV)

1. Construction, operation and comparison of oil-immersed, air-break, air and gas-blast types of circuit-breaker.

MEDIUM VOLTAGE SWITCHGEAR

2. Characteristics and operation of high breaking capacity fusegear, air and oil-break switches, and circuit-breakers, moulded case and miniature circuit-breakers.

TRANSFORMERS

3. Types of distribution transformers in common use, appreciation of economic and environmental factors affecting selection for various applications. Types of 3-phase connection. Buchholz system of protection.

METERING

4. Systems and connections.

SUB-STATIONS

5. Layouts including earthing systems and neutral earthing methods and arrangements. Earth electrode resistance. Protective multiple earthing. Safety and fire precautions. Health hazards.

PROTECTION

6. Common forms of protection of consumers' installation for over-current, reverse current and earth leakage including pilot systems.

DISCRIMINATION

7. Effect of the requirement for discrimination of protection on the layout of an electrical installation.

RATING OF EQUIPMENT

8. Short circuit and time calculations on rating of equipment and circuits. Percentage reactance and impedance.

MEDIUM AND HIGH-VOLTAGE CONSUMERS DISTRIBUTION NETWORKS

9. Appreciation of and calculation of loads and fault levels at various points on consumers networks. Economic consideration of selection of high or medium voltage distribution for various applications and fault levels. Parallel operation of transformers and cables. Voltage drop within a network; regulation.

PART III

Estimating and Tendering

THE LAW

1. Basic principles of contract law. Legal status of estimates, offers and contracts. Sale of Goods Act as applicable to contracting work. Liability under law of tort (Law of delict in Scotland). Effect on contract work of common law.

CONTRACT DOCUMENTS

2. (a) Investigation of the effect on contract price of the form of main and sub-contract for the following:

   (i) RIBA main form of contract: with and without quantities including local authorities edition.
   (ii) NFBTE standard form of sub-contract (green form).
   (iii) CCC/WORKS/1.
   (iv) I. MechE/I.E.E. and ACE Model form of general conditions of contract (A).

   (b) Responsibility of estimator to investigate other forms of contract and sub-contract where these are being used.

TYPES OF CONTRACT

3. (i) Lump sum.
   (ii) Bill of quantities.
   Study of the possible effect on each type of contract of commitments at tender stage such as schedule of rates in conjunction with a lump sum contract, pricing of day-work rates, use of Standard Method of Measurement for contract bills, use of RICS definitions as applied to dayworks. Influence on the tender of Prime Cost and Provisional sums. Preliminaries and their influence on the contract price.

ESTIMATING PROCEDURE

4. (a) Taking off quantities from drawings.
   (b) Assessment of material costs and conditions of purchase.
   (c) Material cost comparison.
   (d) Assessment of labour output: effect of work study feedback (method and time).
   (e) Effect of contract programme: assessment of labour requirements.
   (f) Cost of labour: standard on-costs.
   (g) Assessment of cost of compliance with statutory requirements.
   (h) Assessment of plant and transport requirements and costs.
   (i) Site branch and head office overheads.
   (j) Profit requirements.
   (k) Reconciliation and feedback of contract performance.

Engineering Services Contracts

FORMATION OF CONTRACT

1. Simple contracts and contracts under seal. Contracts for the sale of goods. Construction contracts.

PARTIES TO THE CONSTRUCTION CONTRACT

2. Building owner, main contractor, sub-contractor. Role of professional advisers; architect; quantity surveyor; consulting engineer; clerk of works. Issue and receipt of instructions.

PARTIES TO THE SALE OF GOODS CONTRACT

3. Position between buyer and vendor.

STANDARD FORM CONTRACTS

4. R.I.B.A. forms: private and local authority editions, form of sub-contracts. I.C.E. conditions, form of sub-contracts. CCC/WORKS/1 &

I/MECH/E. forms.

5. Express terms. Implied terms. The purpose of bills of quantities in the contract. Specifications and drawings. Schedules, rates, contracts.
6. Obligations of the main contractor. Obligations of the sub-contractor. Commencement and completion. Determination under the contract.

SUB-CONTRACT DOCUMENTATION

7. Electrical bills of quantities. Specifications and drawings. Schedules rates. As fitted drawings, schematics, circuit drawings.

PURCHASING PROCEDURES – SUB-CONTRACTORS' ARRANGEMENTS

8. Checking the tender documents. Checking the estimate. Enquiries on manufacturers. Manufacturers quotations and conditions of sale. Preferential discounts, payment terms. Checking materials delivered to site. Responsibility for breakages. Responsibility for patent defects. Responsibility for latent defects. Difference between nominated and specified suppliers.

SITE PROCEDURE AND CONTROL

9. Measurement and recording of work. Preliminaries. Site conditions, feedback of information. Site reports. Site meetings and recording of minutes. Phasing of labour and materials, dealing with delays.

FINANCIAL PROCEDURE AND CONTROL

10. Expenditure of prime cost and provisional sum items. Variations, reimbursement. Day works, definitions of prime cost. Fluctuations. Claims under contract. Importance of cash flow during contract. Interim valuations, labour, materials on and off-site. Payment for off-site goods. The final account, issue of certificates of practical completion. Importance of architects final certificate under the contract.

DIVISION OF RESPONSIBILITY FOR INSURANCE

11. Obligations of the building owner, vicarious liability. Obligations of the main contractor. Obligations of the sub-contractor. Warranties and indemnities. Performance bonds.

SETTLEMENT OF DISPUTES

12. By mutual agreement. By arbitration or High Court proceedings.

BANKRUPTCY

13. Effect of bankruptcy on building owner, main contractor and sub-contractors and suppliers.
14. Assignment of contractors. Direct payment.