BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

BGCSE

ELECTRICAL INSTALLATION
SYLLABUS

FIRST PRINTED 1994
REPRINTED SEPTEMBER 2006

MINISTRY of EDUCATION, SCIENCE
& TECHNOLOGY

TABLE OF CONTENTS

GENERAL INTRODUCTION

The Bahamas General Certificate of Secondary Education is a new examination being developed in consultation with the Cambridge University Local Examinations Syndicate.

This examination is designed to assess the achievement of at least 80-85% of Bahamian students on completion of five or six years of secondary level education. It will provide a broadening of opportunity for students to show what they know, understand and can do.

The BGCSE is therefore a very different examination, which is intended to allow expression of concepts, skills, values and understanding by making use of differentiated assessment techniques. While in some subjects, differentiation will be achieved by the levels of response to the same questions, in other subjects, differentiated papers or questions will cater to the different ability levels.

As this is a single examination suitable for almost all secondary students, those who meet the required standards will be awarded grades on a seven point scale A to G. The standard of the current GCE Ordinary level will be maintained as there is no devaluation of excellence in the practice of differentiation.

The BGCSE syllabuses define achievable objectives and the teachers' involvement in coursework assessment should reinforce a sense of positive achievement so that each student will strive to improve himself or herself while working towards realizable targets. This examination will not only test knowledge, but skills of data handling, analysis, judgement, decision making and creative thinking.

Besides the subject content, the syllabuses include wider defined aims which should be studied carefully by teachers.

It is hoped that changes will gradually be seen in our classrooms, whereby students' motivation will increasingly come from themselves as they participate in the various activities related to this new assessment process.

TECHNICAL STUDIES

Technical Studies, formerly Industrial Arts, serve a dual purpose.

1 It is designed to reach the Bahamian population possessing technical ability that will lead them to professions beyond secondary school education.

2 It is also designed to prepare students who, after completion of secondary school, will seek gainful employment in jobs that require technical and vocational skills.

For the purpose of this syllabus, Technical Studies will be defined as those subjects concerned with the application of knowledge that goes with the construction of projects.

This course should encourage design solutions, and help pupils analyze problems through a wide range of materials, applications and methods of construction. The subjects to be covered in Technical Studies are:

1 Auto Mechanics,
2 Building Studies / Construction Technology,
3 Carpentry and Joinery,
4 Electrical Installations,
5 Electronics,
6 Metalwork,
7 Plumbing,
8 Technical Drawing / Graphic Communication,
9 Welding,
10 Woodwork.

AIMS

The Aims of the Technical Studies programme are as follows:

1 The foster awareness, understanding and expertise in those areas of creative thinking which can be expressed and developed through investigation, research, planning, designing, making, evaluation and working with materials and tools.

2 To develop communication skills which are central to design, making and evaluation.

3 To promote with in an educational framework, means of enabling students to sample relevant vocational experience, thus developing a link between secondary education and the world of work.

4 To encourage the development of particular skills and abilities.

5 To provide a base for further study.

6 To encourage students to relate their work, (which should demand active and experimental learning) to their personal interest and abilities.

7 To develop attitudes from safe working skills in the workshop and on the job site.

RATIONALE - ELECTRICAL INSTALLATION

The man power demands of our modern technological society and the needs and interest of youth and adults necessitate an educational program designed to prepare persons for productive citizenship in the world of work.

The Electrical Installation course of study is being designed and prepared to enable the students to become proficient in the tasks and technology necessary to perform the duties required for entry level into the electrical trade. Entry level requires a comprehensive understanding of the fundamentals, operating principles and procedures used to install, service maintain and trouble shoot electrical systems within the industry.

Since technology, methods and equipment are advancing at such a rapid pace in today's industry, the course must not only train a student, but also condition them so that they will continue to keep current with the latest state-of-the-art by self initiative, on the job experience and training. It must also instill in the students a moral and social attitude toward their fellow workers and mankind in general, so as to make them useful and contributing citizens of their country.

ASSESSMENT OBJECTIVES

The assessment objectives listed below are common to all courses in Technical Studies. They are numbered for reference purposes only and the order in which they are presented does not imply any priority or preference. It must however be recognized that the emphasis placed upon each assessment objective will be dependent upon the content of the particular course being undertaken.

Candidates should be able to:

1 describe and apply facts, principles and concepts related to systems design, and their realization and evaluation;

2 demonstrate graphical and other communication skills necessary to give, in a clear and appropriate form, information about an artefact or system;

3 identify problems which can be solved through practical/technological activity;

4 analyze problems which have been identified, or which have been posed by others, and produce appropriate design specifications taking into account technical and aesthetic aspects;

5 identify the resources needed for the solution of practical/technological problems;

6 identify the constraints imposed by knowledge, resource availability and/or by external sources which will influence proposed solutions;

7 gather, order and assess the information relevant to the solution of practical/technological problems;

8 produce and/or interpret data (eg diagrams, flow charts, graphs, electrical blue prints, experimental results);

9 generate and record ideas as potential solutions to problems;

10 appraise solutions to a design problem relative to the initial specification;

11 select and develop a solution after consideration of the constraints of time, cost, skill and resources;

12 plan the production of the selected solution;

13 demonstrate appropriate skills, make or model the artefact or system;

14 propose or make modifications to a product or system both during manufacture and after completion and evaluation;

15 satisfy all mandatory and other necessary safety requirements during the planning and making of an artefact or system;

16 compare and evaluate the performance of an artefact or system against the specification;

17 describe the inter-relationship between design/technology and the needs of society.

The relationship between the Assessment Objectives and the components of the Scheme of Assessment are shown in the following grid;

Objectives	Written Paper 1	Examination Paper 2	Practical	Total
1	2	3	4	9
2	-	2	3	5
3	-	-	3	3
4	2	-	5	7
5	-	2	4	6
6	-	4	-	4
7	-	3	5	8
8	3	-	3	6
9	-	2	3	5
10	2	4	5	11
11	-	2	2	4
12	2	3	-	5
13	3	-	2	5
14	3	-	4	7
15	-	2	-	2
16	3	3	5	11
17	-	-	2	2
	20	30	50	100

The objectives are weighted to give a reasonably accurate indication of their relative importance rather than to provide a precise statement of mark allocations to particular objectives.

SCHEME OF ASSESSMENT

COMPONENT NUMBER	TITLE	DURATION	PERCENTAGE WEIGHTING
1	Written Paper 1	1 hour	20%
2	Written Paper 2	1½ hours	30%
3	Practical Examination	3 hours	50%

DIFFERENTIATION

The scheme of assessment is intended to provide differentiation across the full ability range.

Differentiation will be achieved through questions containing an incline of difficulty in Paper 2 of the Written Examination and questions at the end of or during each practical test in the Practical Examination.

WRITTEN EXAMINATION

Paper 1 will consist of 20 compulsory short-answer questions of increasing difficulty. The questions will cover the whole of the syllabus content. This paper will carry 20% of the total marks.

Paper 2 will consist of up to 4 compulsory structured questions requiring longer and more detailed answers. This paper will carry 30% of the total marks.

Practical Examination 50% of the total marks

Candidates will be required to carry out a series of three practical tests which will be set by the Ministry of Education (Examination Section).

Candidates will each receive an instruction sheet for the practical tests, and will be required to give written answers to short questions at the end of each test (and possibly during some tests). The tests will be marked by the teacher in accordance with the marking scheme supplied by the Ministry of Education. Assessors from the Ministry may visit a centre to assess the teacher's marking.

GRADE DESCRIPTIONS

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall and it might conceal weakness in one aspect of the examination which is balanced by above average performance in some other.

A grade A candidates must show mastery of the core curriculum and an outstanding performance on the more design-based problems.

A grade C candidates must have shown the ability to recall and use knowledge from the syllabus, the ability to select and apply appropriate methods, techniques and procedures and the ability to organize and apply data to a variety of problems.

A grade F candidate will normally have demonstrated some ability to recall knowledge from areas of the syllabus, some ability to select and apply commonly used methods, techniques and procedures and some ability to organize and apply data to a variety of problems.

REFERENCE MATERIALS (BOOKS)

1 National Electrical Code
Cutler-Hammer - 1984 Edition.

2 Canadian Electrical Code
Canadian Standard Associations.

3 Electrical Wiring Residential - 8th Edition.

4 Electrical Wiring Industrial - 8th Edition.

5 Electrical Wiring Commercial - 8th Edition.
R C Mullin.

6 Electrical Power
Motors, Controls, Generators,
Transformers
Joe Kaiser.

7 Electricity One to Seven.

8 Electrical Installation Work.
Theory and Practice.

SAFETY

The importance of good safety practices should be emphasized throughout the course.

Fire and safety codes of electrical practices should be made available to the students, although these may not necessarily be examined.

Workshop layout should be properly organized and all exits clearly marked.

SUBJECT CONTENT

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
1A DISTRIBUTION PANEL/LOAD CENTRE.	**Students should be able to**		
	1.1 determine number size of circuit;	mount panel. surface or flush;	see local, National, Canadian codes building plans.
	1.2 select proper size and type of panel taking into consideration further expansion;		
	1.3 install circuit breakers and fuses;	explain the operation of circuit breakers and fuses;	current and voltage operated. magnetic and bimetallic.
	1.4 determine the rating of fuses and circuit breakers for various pieces of equipment;	calculate load current;	current and voltage and rating
	1.5 connect neutrals and earths in panel;		
	1.6 identify materials required for a given installation	prepare a material list from electrical drawings;	estimate quantities, blue print reading
B LIGHTING FIXTURES, RECEPTACLES AND SWITCHES.	1.7 install wiring boxes in or on floor, wall, ceiling and other surfaces.	differentiate between outlet and junction boxes.	

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
	1.8 select and install the appropriate switch for the specified job;		single pole three and four way, master selector swtich.
	1.9 connect wires to fittings, outlets and switches observing colour code and polarity;		
	1.10 wire incandescent light circuits with single pole, three way, four way and dimmer switches;		
	1.11 wire special control devices, eg. photo controls, time switch, pressure switch, lighting contactor, etc.	recognize types of special control devices;	
	1.12 wire an air conditioner, electric dryer, electric range/ oven, welder, water heater circuit with cable and conduit;		
	1.13 wire fluorescent light circuits with cable and conduit;	select types of flexible conduit eg Bx.	
	1.14 draw and connect discharge lamp circuits;	describe the operation of discharge lamps and control gear;	Fluorescent lamp, mercury vapour and sodium lamp circuits.

TOPIC	OBJECTIVES		SUPPLEMENT	NOTE
	1.15	locate and rectify faults in discharge lamp circuits;		
	1.16	list advantages and disadvantages of incandescent and discharge lamps;	become familiar with methods of illumination and stroboscopic effect;	halogen, neon-lighting local, National, Canadian electrical codes.
	1.17	install wall and ceiling fixtures;		
C. ELECTRICAL WIRING SYSTEMS	1.18	**Cut and install conduit, ducting** and trunking;		
	1.19	cut, thread and bend rigid conduit for a specified job	select from the following conduits, metal/ galvanized, pvc, EMT (thinwall) etc.	pipe cutter, hickey, blow torch, die, offset, 90° angle etc.
	1.20	select appropriate fittings for conduit, conduit, ducting and trucking.		bends, tees, locknuts, bushings, couplers, adapters, clips etc.
	1.21	install cables in conduit, ducting and trunking.	use fish tapes or draw wires.	
2 SERVICE ENTRANCE MAINS AND METER CIRCUITS	2.1	explain types of service, point of supply, entrance cable, consumer's terminal, service line;	differentiate between an underground and an overhead service.	Application of local codes.

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
	2.2 explain the requirements for the installation of consumer's entrance cable and meter circuits;	identify overhead service line with consumer's cable and meter circuit on consumer's' building or private poles. identify underground entrance cable on supply authority's pole and meter circuit on consumer's building.	
	2.3 determine the minimum and maximum value of connecting load currents;		diversity factor, local codes.
	2.4 select the appropriate type of meter socket for a given load;	use local codes to determine indoor or outdoor meter.	
	2.5 select the appropriate type and size of entrance cable for a given command;		type of supply conduit or pvc armoured.
	2.6 determine the best location for a meter and position the meter;		
	2.7 install service entrance cable for single phase and 3-phase, 4-wire meter sockets.	select appropriate weatherhead or glands, termination lugs and connectors.	

TOPIC		OBJECTIVES	SUPPLEMENT	NOTE
3 EARTHING/GROUNDING				
	3.1	explain the principles of grounding electrical systems;	identify ground continuity conductor and electrode.	
	3.2	Choose correct size conductors for grounding systems.		See local, National, Canadian codes.
4. SUPPLY SYSTEMS	**4.1**	**identify type of supplies which are** distributed by the supply authority.	**recognize single phase 2 and** 3-wire 3-phase 4-wire systems.	**local codes.**
	4.2	draw schematic diagrams of 3-phrase 4-wire systems.	use delta connected transformers winding with earthed neutral.	
	4.3	state the applications of 3-phrase 4-wire systems;	use wye connection transformer utilizing neutral point and load balancing.	
	4.4	state the application and maximum load demand for single phase and 2-wire and 3-wire supplies;		domestic and commercial installation.
	4.5	select the most suitable type of supply for a given installation;	become familiar with domestic, commercial and industrial installations.	

TOPIC		OBJECTIVES	SUPPLEMENT	NOTE
	4.6	install and connect supply cable and distribution panel for single and 3-phase supplies.		Local, National, Canadian codes.
ELECTRICAL CONDUCTORS AND CABLES				
	4.7	explain the difference between between a cable and a conductor;	list components of a cable eg insulator, conductor, mechanical protection.	
	4.8	describe the characteristics of conducting materials;		caution in connecting dis-similar metals.
	4.9	distinguish between good electrical and terminal conductors and good terminal and electrical insulators;	list types of conductors and insulators, eg aluminium, copper, brass, silver, etc insulators; rubber, pvc, mica porcelain, etc.	
	4.10	identify various types of cables;		types of insulation pvc, mineral, rubber, etc.
	4.11	join and terminate electrical cable.	use solder and and mechanical connectors.	
5 MEASURING INSTRUMENTS	5.1	describe the construction and operation of measuring instruments;		

TOPIC	OBJECTIVES		SUPPLEMENT	NOTE
	5.2	select and use measuring instruments to measure current voltage, resistance and power.	read and interpret instrument scales accurately	linear and non-linear See Appendix 1.
	5.3	connect electrical measuring instruments correctly and safely;	use a systematic method of testing.	
	5.4	construct a simple continuity tester;	test lamp.	
	5.5	test for polarity and continuity using appropriate instruments;	recognize open and short circuits;	
	5.6	test for insulation resistance and for ground continuity;		
	5.7	test for earth resistance.		electrode test.
6 PHYSICS OF ELECTRICITY	6.1	**define the structure** of matter;	**identify forms and properties** of matter.	
	6.2	define static electricity and ways of producing electricity;		friction, magnetism, chemical action, etc.
	6.3	understand and use the units for current, resistance and electromotive force;		

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
7 CIRCUIT CONFIGURATIONS			
	7.1 define, list and draw the components of an electric circuit;		load, power source, wire control, etc.
	7.2 understand and use Ohm's law.	state Ohm's law equation $I = E/R$.	
	7.3 recognize resistors in series and parallel circuits and perform calculations.		$R_T = R_1 + R_2$ $R_T = \frac{R_1 R_2}{R_1 + R_2}$
	7.4 apply Ohm's law to various types of circuits.		
	7.5 state the relationship between current, voltage and resistance, and perform simple calculations in series and parallel circuits.		
	7.6 calculate power in series and parallel circuits;	use formulae $P = EI$, $P = I^2 R$ $P = \frac{E^2}{R}$.	
	7.7 define Kirchhoff's law in relation to electrical energy-power.		DC and AC circuits.
	7.8 understand the relationship betweem mechanical and electrical energy.	describe energy transfer sources.	

TOPIC	OBJECTIVES		SUPPLEMENT	NOTE
	7.9	understand the difference and the relationship between heat and electrical energy;		
	7.10	define the terms cycle, frequency, period, amplitude, instantaneous value, rms value, and phase with reference to sinewave.		
	7.11	convert peak value to rms and average value;	compare direct current with alternating current.	
8 PRIMARY AND SECONDARY CELLS	8.1	**understand the use and limitations of different types of battery for energy** storage purposes;		
	8.2	connect cells in series and parallel as a source of power.	select appropriate type of cells for simple specified application	dry cells, ni-cads, lead acid, etc.
	8.3	determine and test for the resultant voltage of cells connected in eries and parallel;		polarity.
	8.4	differentiate between e.m.f. and p.d. of a cell;	calculate internal resistance.	

TOPIC	OBJECTIVES		SUPPLEMENT	NOTE
	8.5	charge and maintain secondary cell;	measure levels of charge and give advantages and character-istics of lead acid alkaline cells.	hydrometer and high rate discharge tester.
9 MAGNETISM, ELECTRO-MAGNETISM AND INDUCTION	9.1	explain the principle of magnetism;		
	9.2	apply the basic laws of magnetism;	state Faraday's law;	
	9.3	identify types of magnetic materials;	distinguish between magnetic and non-magnetic materials.	magnetic induction.
	9.4	magnetize a piece of metal by mechanical or electrical method.	distinguish between the magnetic properties of iron and steel.	
	9.5	Wind a coil for an electro magnet;		
	9.6	determine the direction of magnetic field around a current carrying conductor.	state Fleming left and right hand rules, and Lenz's law.	
	9.7	plot the magnetic field around a single conductor		

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
	9.8 determine the direction of force between two current carrying conductors in parallel;		
10A ELECTRICAL MACHINES D C MACHINES			
D C	10.1 explain the construction and operation of d.c. generators;	explain what is meant by self-excited and separately excited;	
	10.2 explain the construction and operation of d.c. motors;		
	10.3 explain the effect of back emf.		
	10.4 identify types of motor connections eg series, shunt, compound;	connect d.c. motor to supply mains;	
	10.5 reverse direction of motor rotation.		
	10.6 explain the function of the face plate starter and identify points;		overload coil and no-volt release.
	10.7 service and maintain d.c. motors.		
B ELECTRICAL MACHINES A C	10.8 explain the **construction and** operation of a.c. motors;	identify single **and 3-phase motors,** capacitor start, squirrel cage, induction motors.	

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
	10.9 connect single phase and 3-phase motors to supply mains.		duel voltage connection terminal designation.
	10.10 reverse direction of motor rotation;	understand the factors affecting reversal of rotation, main auxiliary winding, capacitor, and phase displacement.	
	10.11 explain the difference between synchronous speed and rotor speed;		slip, pole frequency.
	10.12 service and maintain motors and auxiliary equipment.	check insulation resistance of winding; test inductors, capacitors, relays and centrifugal devices.	
	10.13 explain the construction and operation of motor starters.		magnetic starter, stop, start, jog and reverse.
	10.14 connect motor starters using wiring diagrams.		push buttons, internal and remote.
11 TRANSFORMERS			
	11.1 describe the effects of inductors in a.c. electrical circuits.	state Lenz's law.	

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
	11.2 explain the construction and principle of operation of transformers in electrical circuits.	explain the difference between step-up and step-down transformers, auto, double wound and current transformers.	self inductance mutual inductance, magnetic field.
	11.3 calculate the voltage, current and turns ratios of transformers	use formulae, eg. $\frac{NP}{NS} = \frac{VP}{VS}$ $= \frac{IS}{IP}$ etc	transformer action (no load and on load).
	11.4 identify transformer core formations and explain causes of losses;		core laminations, copper and iron losses.
	11.5 connect transformers in circuits to supply load,	understand single phase connections identify primary and secondary connections.	
	11.6 describe the procedures for connecting two single phase transformers in parallel.	understand additive and subtractive polarity.	
12 SIGNAL CIRCUITS	12.1 explain the **principle** of bells, buzzers and chimes;	bell transformer **annunciators.**	
	12.2 draw and connect various bell/buzzer circuits;		

TOPIC	OBJECTIVES		SUPPLEMENT	NOTE
	12.3	connect and test burglar and fire alarm circuits;	understand normally open normally closed circuits, relays magnetic reed switches.	
	12.4	explain the principles of operation of microphones and receivers; operation.	connect a simple two-station intercom.	telephone receiver and transmitter
13 CAPACITORS				
	13.1	explain the construction of various types of capacitors;		types, paper, mica electrolytic, polyester, etc.
	13.2	connect capacitors in electrical circuit;	calculate total capacitance in series and parallel;	
14 RECTIFICATION				
	14.1	describe the action of a semi conductor diode;	explain the function of a rectifier,	P.N.junction, forward and reverse bias, peak inverse voltage.
	14.2	describe the function of power transformer in rectifier circuits.	understand bridge and bi-phase, fuel wave rectification.	
15 TOOLS				
	15.1	identify the different types of tools and explain their uses.		tools as listed in Appendix 1.

TOPIC	OBJECTIVES	SUPPLEMENT	NOTE
	15.2 select and demonstrate the proper use of tools for a given job.		care of tools.
	15.3 read and interpret manufacturers' instructions carefully before using power tools.		drill press, grinders, etc.

APPENDIX 1

List of Tools and Instruments

TOOLS

Combination Pliers - Insulated
Side Cutting Pliers - Insulated
Long Nose Pliers (Bird Beak)
Lineman's Pliers - Insulated
Slip Joint Pliers (Channel Lock, Groove Joint)
Screwdrivers: Various Size Tips: Flat, Robertson & Phillips
Adjustable Wrenches (Pipe Wrench)
Open End Spanners (Assorted Sizes)
Socket Set (Small)
Bending Springs
Metal Conduit Benders
Stocks and Dies
Reamers
Files: Flat, Round and Half-Round
Pipe Vices, Bench Vices
Allen Keys (Allen Wrenches) Hexagonal Wrenches
Hacksaws (Large and Small)
Centre Punches
Cold Chisels
Taps and Tap Wrenches
Wire Strippers
Knives (with locking Blades)
Soldering Irons (25 - 60 W)
Electrician's Hammers
Blow Torch
Ball Pien Hammers (1 KG)
Ball Pien Hammers (227 G)
Tap Hammers
Knock Out Punches
Key Hole Saws
Portable Drilling Machine
Set of Drill Bits
Masonary Bits
Rawl Drills
Gimlets
Fish Tapes
Neon Test Light
Head Box.