



**CARIBBEAN EXAMINATIONS COUNCIL**

**CARIBBEAN SECONDARY EDUCATION CERTIFICATE®  
EXAMINATION**

**ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**TECHNICAL PROFICIENCY**

**SCHOOL-BASED ASSESSMENT**

**LAB-BOOK AND LABORATORY EXERCISES**

The lab-book for EACH candidate MUST be returned to CXC no later than April 30 in the examination year.

Name of Candidate: \_\_\_\_\_

Name of School: \_\_\_\_\_

Territory: \_\_\_\_\_

Candidate's Reg. No.: \_\_\_\_\_

**SUMMARY OF CANDIDATE'S MARKS**

**LABORATORY EXERCISES**

Laboratory Exercises	No. _____	No. _____	No. _____	No. _____	No. _____	TOTAL
Teacher's Marks						
CXC's Marks						

Name of Teacher: \_\_\_\_\_  
(Block Capitals)

Signature of Teacher: \_\_\_\_\_

Date: \_\_\_\_\_

**ELECTRICAL AND ELECTRONIC TECHNOLOGY**  
**SCHOOL-BASED ASSESSMENT**  
**TECHNICAL PROFICIENCY**

**The laboratory exercises which are set out in this booklet are not intended to be used by candidates as a self-instruction manual.**

**IMPORTANT NOTES TO THE TEACHER:**

1. Where procedural steps have been omitted from an exercise, the teacher is expected to assist the candidates in setting them out in a logical and sequential order in their lab-books.
2. Where applicable, equivalent metric dimensions may be used.
3. Where components specified are not available, the equivalent or nearest in value may be used.
4. Earthing requirements to be observed must be consistent with wiring regulations.
5. Where there is no apparatus listed, the teacher is requested to advise the candidates to list these in their lab-book.
6. The candidates should adhere to the format indicated for writing up the experiments in the lab-book.
7. The teacher should ensure that the candidates carefully state the conclusions for EACH exercise. These should express clearly and concisely what has been learnt. Any discrepancies or deviations from the normally expected theoretical results should be accounted for.
8. The teacher is required to mark the candidates' work during the exercise and also on completion.
9. Teachers are reminded to mark according to the detailed mark scheme supplied, to ensure consistency in marking.

**MODERATION OF SCHOOL-BASED ASSESSMENT**

1. An external Moderator will visit each school twice during the final year. On the first visit he/she will assess the **process** of conducting the laboratory exercises by EACH student. On the final visit he/she will reassess the completed laboratory exercises (**product**) of a sample of FIVE students.
2. The Moderator **MUST** select the sample (for product evaluation) based on the TOTAL SBA scores awarded by the Teacher. To facilitate this, the teacher **must** make a copy of his/her assessment on the candidate's record sheet available to the moderator.
3. The first visit should be scheduled for January/February and the final visit for April, of the year of the examination.

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**ELECTRICAL AND ELECTRONIC TECHNOLOGY**  
**SCHOOL-BASED ASSESSMENT**  
**TECHNICAL PROFICIENCY**

**The assessment will be based on laboratory exercises, to be performed between September and March, by candidates entered for the examinations.**

**LABORATORY EXERCISES**

1. EACH candidate offering the Electrical and Electronic Technology examination is required to perform FIVE laboratory exercises.
2. EACH exercise is worth 18 marks for the performance skills.
3. The teacher is required to use the mark scheme supplied by CXC to assess the exercises.
4. Whole marks only are to be awarded. (No fractional parts).
5. EACH candidate's marks MUST be accurately recorded in the lab-book, and lab-books MUST be sent to reach CXC by April 30.
6. EACH candidate will be supplied with a lab-book by CXC, in which he/she MUST record the conduct and findings of the FIVE exercises selected.
7. The SBA component is worth 40% of the total marks, and is COMPULSORY for ALL in-school candidates.

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## WRITTEN ASSIGNMENT

The written assignment will take the form of a report of about 1000 – 1200 words based on the common modules. These are:

Safety Health and Welfare  
Introduction to Computer  
Impact of Technology on Society

Candidates are to demonstrate their full understanding of the concepts relating to these modules. They should produce a report that uses word-processing technology. Candidates may also use other software packages (spreadsheets or databases) to do any analysis that may be necessary to enhance the presentation of the report.

The report should be a critical analysis of a particular institution, business or theme which has relation or relevance to the Unit(s) or Subject(s) being studied.

The particulars of the written assignment must be approved by the teacher before any work is started. Written assignments will be marked by the teacher and moderated at marking centres during the marking exercise. The teacher's assessment on the candidate's record sheet is to be submitted to reach CXC by April 30 in the year of the examination.

The written assignment will be marked as follows:

(a)	Introduction	–	2 marks
(b)	Content	–	9 marks
(c)	Presentation	–	9 marks
(d)	Summary	–	3 marks
(e)	Communication of Information	–	<u>7</u> marks
			<u>30</u> marks

**NB: The written assignment is an individual project.**

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### EXERCISE 1

Two lamps with single-pole switch control; switch-start fluorescent lamp with TWO 2-way and an intermediate control using conduit system of wiring

#### Objectives:

The candidate will be required to

- (i) identify the various components which make up the circuit
- (ii) construct a circuit to control different lighting loads from various positions
- (iii) distinguish between the various controls and their operation
- (iv) adhere to the codes/regulations or standard specifications with regard to the type of installation being done
- (v) analyse the operation of the fluorescent circuit.

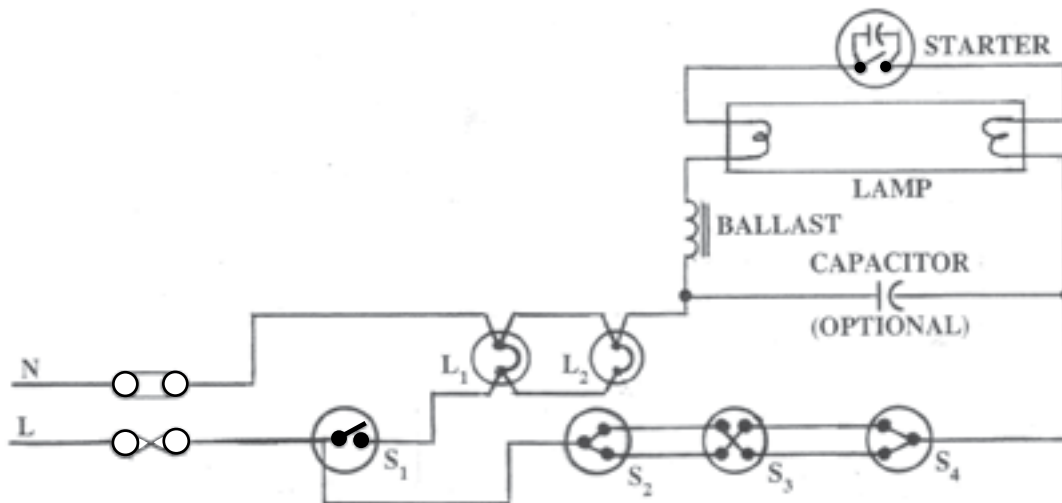


Figure I

#### Apparatus:

- 20 mm conduit (metallic or non-metallic)
- 20 mm tee-box with lid/or equivalent box
- Outlet box for single-way switches
- Outlet boxes for 2-way switches
- Outlet box for intermediate switch
- Clamp-straps for conduit
- Conduit ends
- Main switch-fuse or circuit breaker panel
- Ceiling lamp holders
- 1.5 mm<sup>2</sup> single core cable (red and black)
- 0.5 mm<sup>2</sup> or equivalent flexible cord
- Lamp ballast and starter
- Lamp and lamp holders
- 1.5 mm<sup>2</sup> cable E.C.C.
- Ohmmeter or testing device
- Cleaning-down system
- Capacitor (optional)

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Procedure:

- (i) Install conduits/boxes to accommodate fixtures.
- (ii) Draw in conductors to accommodate wiring diagram as shown in Figure I.
- (iii) Lay out the component parts of fluorescent circuit on project board.
- (iv) With the aid of the circuit diagram, make the appropriate connection (within the confinement of the local regulation or standard specification).
- (v) Make soldered connections where necessary.  
(N.B. Earthing of the fluorescent fixture is very important.)
- (vi) Test for continuity, polarity and earthing in the circuit.
- (vii) Test for the correct connection to this supply system.

Questions:

- (a) What is the function of the capacitor across the supply to the fluorescent lamp when it is used? **(1 mark)**
- (b) What would be the effect on the circuit should the starter be taken out after the lamp is started?  
Give a reason for your answer. **(1 mark)**
- (c) If the single pole switch in Figure I is reconnected to become a master-switch, should there be any major alteration within the circuit? State the MAIN reason for your answer. **(1 mark)**
- (d) With reference to Figure I on page 5, where would such a circuit usually be used? **(1 mark)**
- (e) What effect would occur if the intermediate switch,  $S_3$ , were replaced by a double-pole switch? **(1 mark)**
- (f) Should  $L_1$  become open-circuited, how would the rest of the circuit be affected? **(1 mark)**

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OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:



CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	<ul style="list-style-type: none"><li>Communicates information in a logical way using correct grammar and appropriate jargon of this field</li><li>Communicates information that is not logical or jargon of the field</li></ul>			
TOTAL		18		

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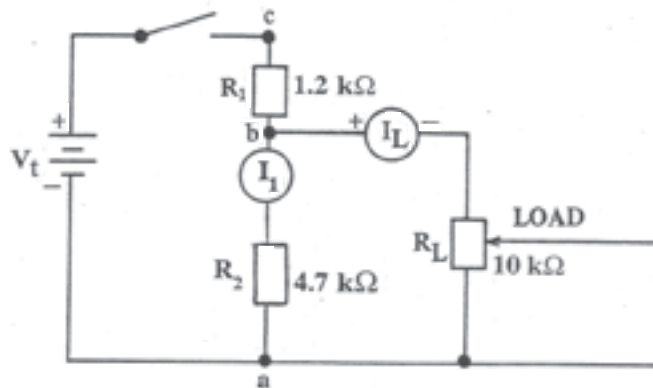
## EXERCISE 2

### Voltage - divider circuits (loaded)

#### Objectives:

The candidate will be required to

- (i) determine analytically the effects of a load on the voltage relationships in a resistive voltage -divider circuit
- (ii) confirm experimentally the results of (i) above.



**VOLTAGE DIVIDER WITH VARIABLE LOAD**

**Figure II**

#### Apparatus:

Power supply - regulated variable d.c.

0 - 10 mA meter, ohmmeter

Resistors -  $\frac{1}{2}$  W, 1.20 kW,  $\frac{1}{2}$  W 4.7 kW

10 kW 2W potentiometer

SPST switch

#### Procedure:

- (i) Connect the circuit as shown in Figure II.
- (ii) Maintain a constant 10 V from the power supply throughout the test.

Copy Table I, on page 11, in your lab-book.

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- (iii) With a load current,  $I_L$ , of zero (load resistor,  $R_L$ , open circuit), measure and insert in Table I the values of  $I_1$ ,  $V_{bc}$ , and  $V_{ab}$ .
- (iv) Close the load circuit and adjust the load resistor to give a load current of 2 mA.
- (v) Record the value of  $I_1$ ,  $V_{bc}$  and  $V_{ab}$ .
- (vi) Measure the resistance of  $R_L$ .
- (vii) Repeat procedure (iv - vi) for values of load current of 3 mA and 6 mA.

<b>MEASURED VALUES</b>						
	<b>V</b>	<b><math>I_L</math> LOAD CURRENT mA</b>	<b><math>I_1</math> mA</b>	<b><math>V_{bc}</math> VOLTS</b>	<b><math>V_{ab}</math> VOLTS</b>	<b><math>R_L</math> OHMS</b>
Step 1	10	0				
Step 2	10	2				
Step 3	10	3				
Step 4	10	6				

**Table I**

**Questions:**

- (a) Explain how load current varies with load resistance. **(1 mark)**
- (b) What is the effect on  $I_1$  as the load current  $I_L$  increases? **(2 marks)**
- (c) Explain the effect of  $V_{ab}$  and  $V_{bc}$  at the divider taps as the load current increases. **(2 marks)**
- (d) At Step 4, if  $R_2$  is open-circuited, what would be the effect on the voltage across  $R_L$ ? **(1 mark)**

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OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:

CONCLUSION:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	• Communicates information in a logical way using correct grammar and appropriate jargon of this field			
	• Communicates information that is not logical or jargon of the field			
TOTAL		18		

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### EXERCISE 3

Connect line voltage photocell to operate lamps.

Objective:

The student will be able to connect a photocell to control lighting using a relay.

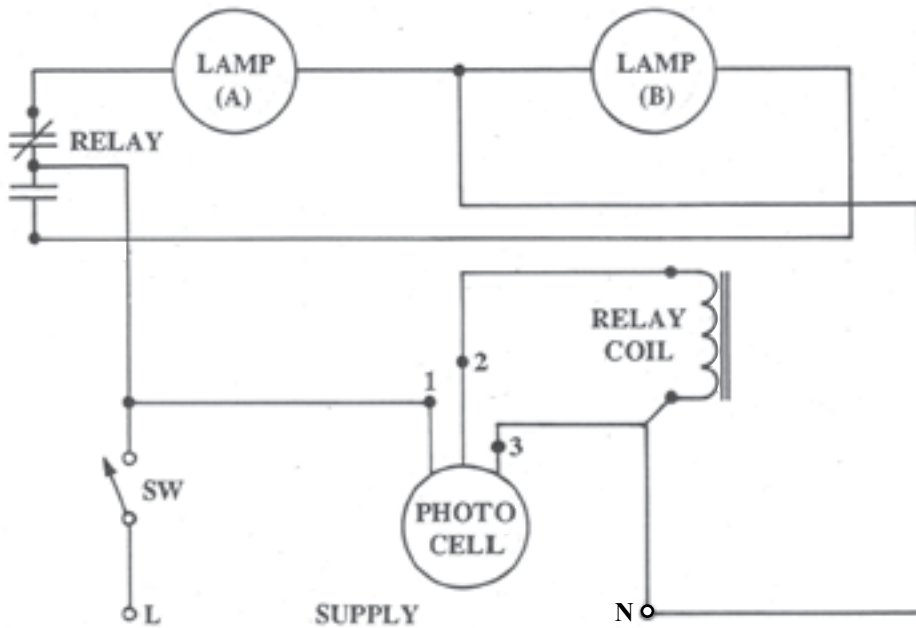


Figure III

Procedure:

- (i) Connect circuit as shown in Figure III.
- (ii) Cover photocell and energise circuit.
- (iii) Remove cover from photocell.

Questions:

- (a) Which of the lamps lit when the photocell was covered? **(1 mark)**
- (b) Did both lamps light-up simultaneously at any time? **(1 mark)**
- (c) How will a faulty relay coil affect the circuit? **(2 marks)**
- (d) How would a faulty photocell be detected? **(2 marks)**

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OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:

CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	<ul style="list-style-type: none"><li>Communicates information in a logical way using correct grammar and appropriate jargon of this field</li><li>Communicates information that is not logical or jargon of the field</li></ul>			
TOTAL		18		

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### EXERCISE 4

**Connect and test full-wave rectifier with smoothing choke and capacitors.**

**Objective:** (Use oscilloscope/multimeter.)

The candidate will be required to

- (i) determine from tests undesirable characteristics of d.c. output
- (ii) connect bridge rectifier circuits using solid state diodes into smoothing circuit.

**Procedure:**

Connect the full-wave bridge circuit.

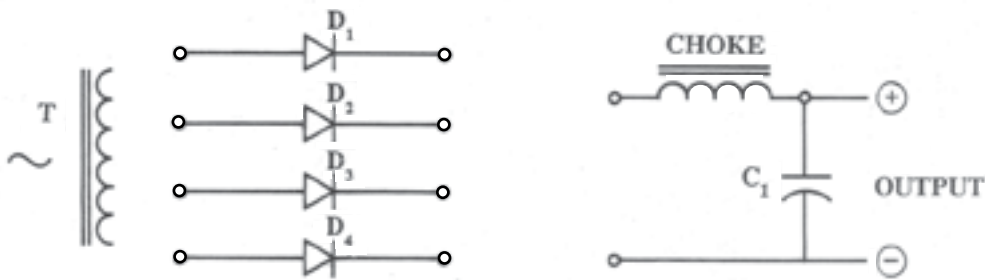


Figure IV

**Questions:** (Circuit to remain connected to answer questions.)

What effect is there on the circuit when

- (i) the capacitor  $C_1$  is removed? **(1 mark)**
- (ii) the choke is removed? **(1 mark)**
- (iii) the diode  $D_2$  is removed? **(2 marks)**
- (iv) one diode is reversed? **(2 marks)**

SCHEMATIC DIAGRAMS:

OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:

CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	<ul style="list-style-type: none"><li>• Communicates information in a logical way using correct grammar and appropriate jargon of this field</li><li>• Communicates information that is not logical or jargon of the field</li></ul>			
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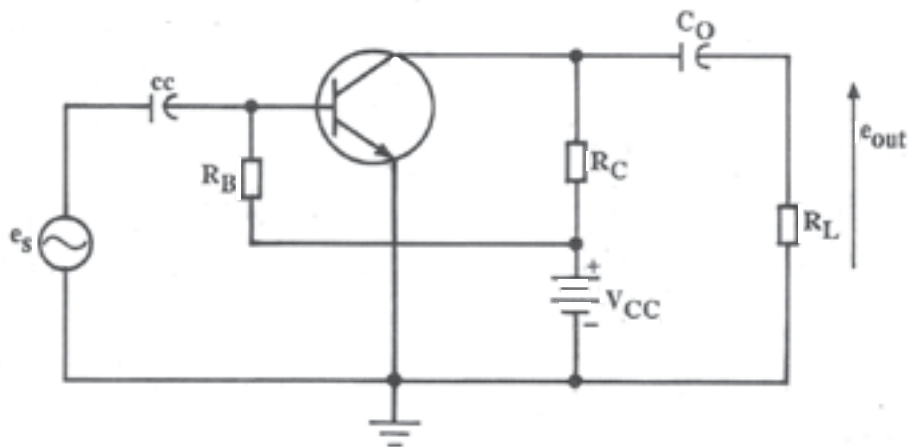
### EXERCISE 5

**Connect and test basic transistor amplifiers.**

**Objective:**

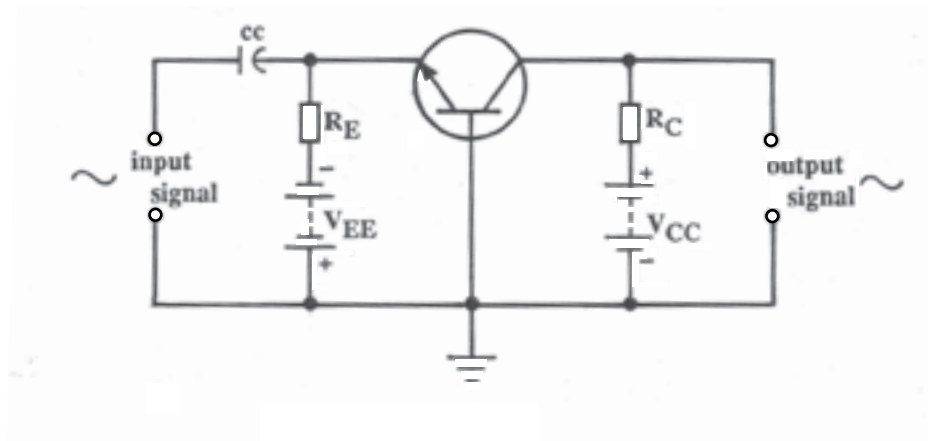
The candidate will be required to

- (i) distinguish among the C.B. , C.E. and C.C. configurations, limitations and characteristics.



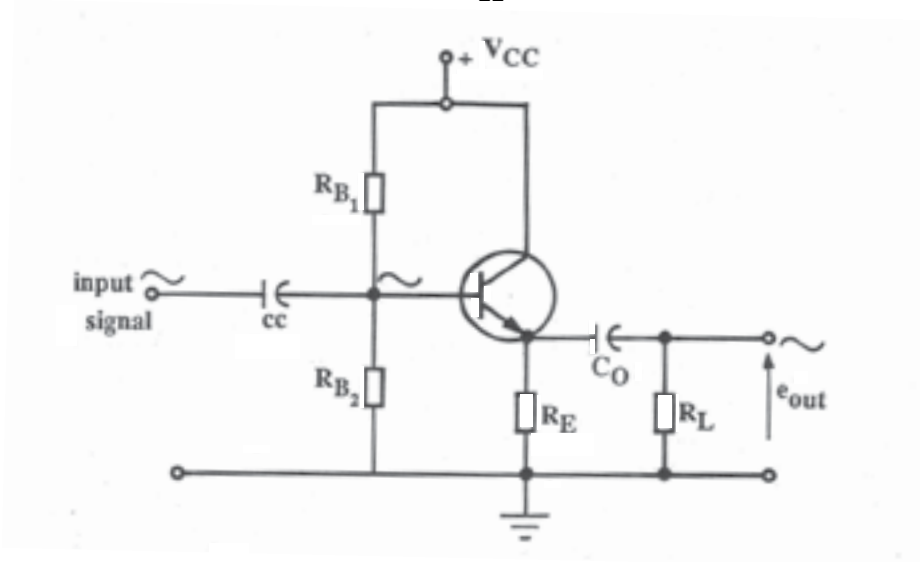
**CE AMPLIFIER**

**Figure V (a)**



**CB AMPLIFIER**

**Figure V (b)**



**CC AMPLIFIER**

**Figure V (c)**

**Procedure:**

- (i) Use ohmmeter to test transistor's functionality.
- (ii) Connect C.E. circuit as an a.c. amplifier.
- (iii) Apply input signal and record results.
- (iv) Repeat step (iii) for a different value of input.
- (v) Repeat steps (iii) and (iv) for C.B. and C.C. configuration.

Circuit	Input Voltage	Wave-form		$V_{RL}$	$I_L$	Calculated Power Output (mW)	Voltage Gain	Transistor Type
		IN	OUT					
C.E	(i)							
	(ii)							
C.B.	(i)							
	(ii)							
C.C.	(i)							
	(ii)							

**Table II**

**Questions:**

- (a) Why is the C.E. configuration the most widely used in consumer electronics equipment? **(1 mark)**
- (b) Which of the configurations gives phase reversal between output and input? **(1 mark)**
- (c) Which configuration has the highest voltage gain? **(1 mark)**
- (d) Which configuration has the lowest input resistance? **(1 mark)**
- (e) Which function of a transistor amplifier should be
  - (i) forward-biased? **(1 mark)**
  - (ii) reversed-biased? **(1 mark)**

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OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:

CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	<ul style="list-style-type: none"><li>• Communicates information in a logical way using correct grammar and appropriate jargon of this field</li><li>• Communicates information that is not logical or jargon of the field</li></ul>			
TOTAL		18		

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## EXERCISE 6

### Disassemble/test and connect split-phase and universal motor.

#### **Objective:**

The candidate will be required to

- (i) distinguish between the construction features of the split-phase and universal motors
- (ii) perform resistance tests to determine faults in motor winding
- (iii) complete the operation of the two motors.

#### **Procedure:**

- (i) Disassemble motors and observe components in each type.
- (ii) Test windings for grounds/shorts to frame using ohmmeter.
- (iii) Record data from the name plates of motors.
- (iv) Reassemble, connect and test motors for operation in both directions.

#### **Questions:**

- (a) What device is used to disconnect the starting winding in the split-phase motor after it is started? **(1 mark)**
- (b) How could the direction of rotation of split-phase motor be reversed? **(1 mark)**
- (c) Should a starting winding in the split-phase motor fail to energise, what will be the result? **(1 mark)**
- (d) Should sparking occur at the brushes of a universal motor, what could be possible causes? **(1 mark)**
- (e) How could the direction of rotation of the universal motor be reversed? **(1 mark)**
- (f) What special feature is the universal motor known for? **(1 mark)**

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SCHEMATIC DIAGRAMS:

OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:

CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	<ul style="list-style-type: none"><li>• Communicates information in a logical way using correct grammar and appropriate jargon of this field</li><li>• Communicates information that is not logical or jargon of the field</li></ul>			
TOTAL		18		

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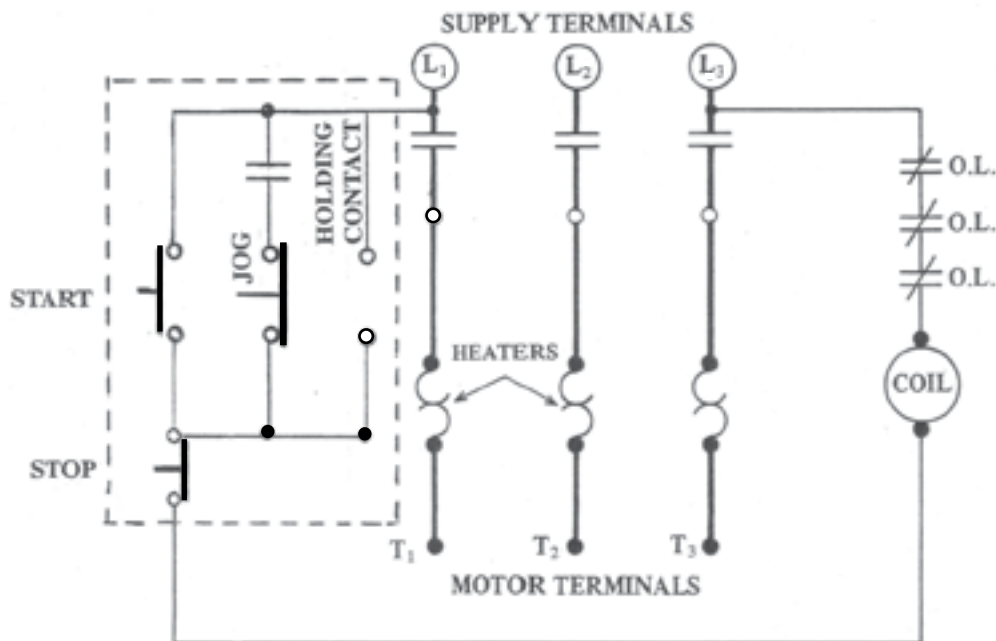
### EXERCISE 7

#### Direct-on-line three-phase magnetic starter with stop-start control stations.

##### Objectives:

The candidate will be required to

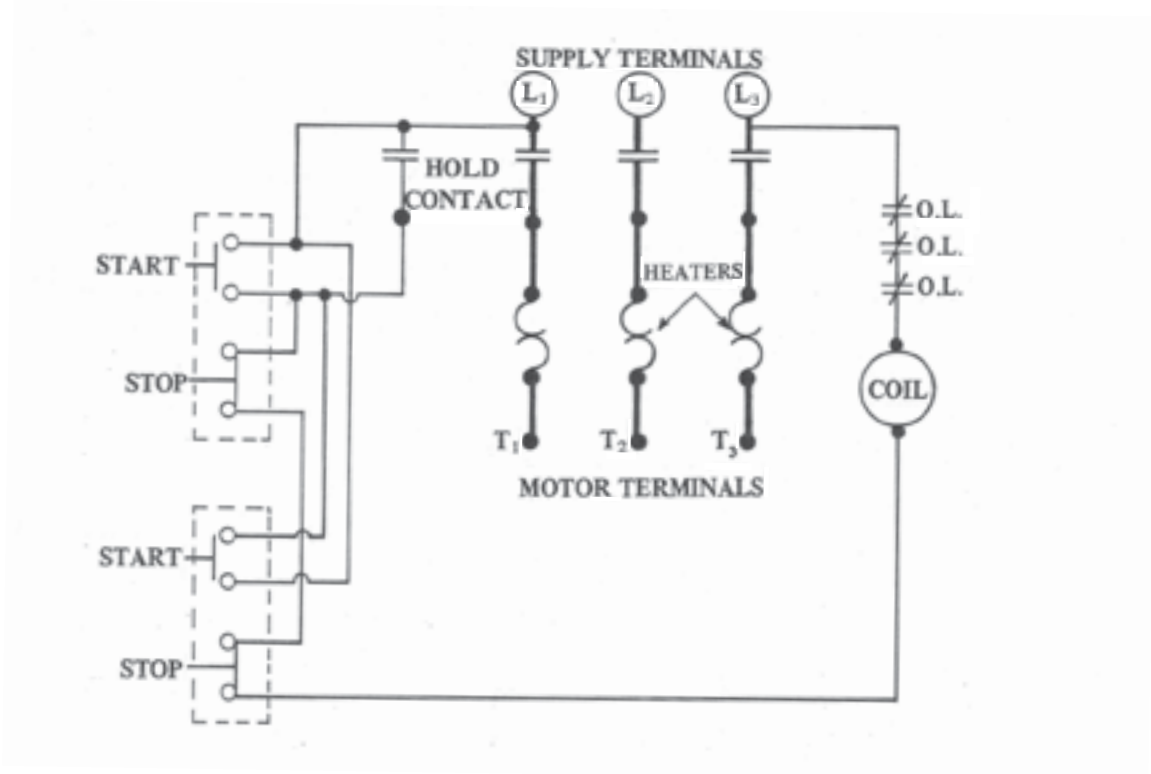
- (i) identify common electrical symbols used in motor control diagrams
- (ii) connect starter with remote stop/start station
- (iii) describe the basic operation of the control circuit and the power circuit for magnetic three-phase starters and connect circuitry.



**DIRECT-ON-LINE STARTER SCHEMATIC  
(CONTROLLED FROM ONE STATION)**

**Figure VI**

**Note:** Teachers should introduce the JOG control to this starter circuit.



**DIRECT-ON-LINE STARTER SCHEMATIC  
(CONTROLLED FROM TWO STATIONS)**

**Figure VII**

**Apparatus:**

- One three-phase magnetic starter
- Two N.C. push buttons (stop buttons)
- Two N.O. push buttons (start buttons)
- Connecting wires
- (Note: Use individual stop/start station if available.)

**Procedure:**

- (i) Connect single stop/start push button control circuit with three-phase magnetic starter according to schematic diagram (Figure VII).
- (ii) Check connections before connecting to supply.
- (iii) Check for proper operation of stop/start station and starter.
- (iv) Disconnect from supply.

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**Procedure Cont'd:**

- (v) Connect stop/start/jog stations according to schematic diagram (Figure VII), and wire system with stations away from each other.
- (vi) Connect circuit to three-phase supply and test for proper operation.
- (vii) Observe possible faults which may occur in the power and control circuits.
- (viii) Disconnect circuit and dismantle components.

**Questions:**

- (a) What type of overload device is incorporated in the starter used? **(1 mark)**
- (b) Name TWO other types of overload devices used in motor starters. **(1 mark)**
- (c) What factors should be taken into account when selecting/setting overload devices for starters? **(2 marks)**
- (d) Make a sketch of the control circuit, modified to be used with a 2-wire control device such as a high water-level switch for a storage tank and pump. **(2 marks)**

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OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:



CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	• Communicates information in a logical way using correct grammar and appropriate jargon of this field			
	• Communicates information that is not logical or jargon of the field			
TOTAL		18		

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## EXERCISE 8

### Logic Circuits

#### **Objectives:**

Students will be able to

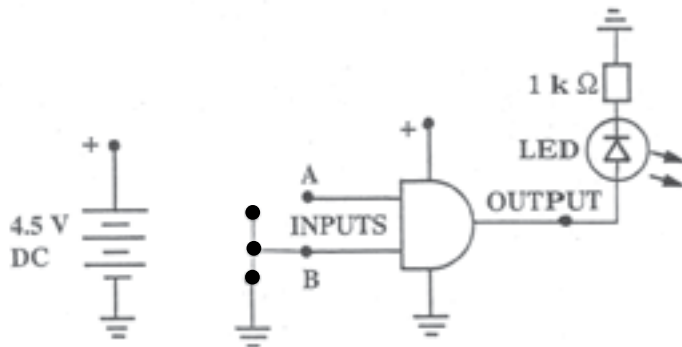
- (i) distinguish between integrated circuits and discrete components
- (ii) identify pin connections of a typical I.C. device such as an AND gate
- (iii) connect an AND gate I.C. in a circuit and verify its truth table
- (iv) verify how an AND gate function can be replaced by two mechanical switches.

#### **Apparatus:**

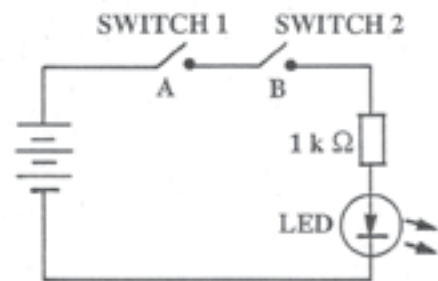
1. One prototype solderless breadboard and connecting wires.
2. Two miniature single-pole switches.
3. Three 1.5 V dry cells and cell holder.
4. One AND gate I.C. and socket.  
(7408 – Quad two input AND gates)
5. Two miniature alligator clips.
6. One 1 000  $\Omega$  carbon-composition  $\frac{1}{4}$  W resistor.
7. One Light Emitting Diode – (LED – 1.5 V, 5 mA or more).

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Procedure:



**Figure VIII**



**Figure IX**

- (i) Insert the I.C. socket in the solderless breadboard. Insert the AND gate I.C. in the socket.
- (ii) Identify the pins for the power supply and the ground for the I.C.
- (iii) Identify the pins for the inputs and the output of the AND gate on the I.C.
- (iv) Test the AND gate using Figure VIII and verify the truth table for the gate.
- (v) Using Figure IX, verify with the help of a truth table, how an AND gate functions can be replaced by two mechanical switches?

Questions:

1. What is an I.C.? **(1 mark)**
2. How do you identify pin connections on AND gate I.C. chip? **(1 mark)**
3. Which logic gate is similar to the function of two series switches? **(1 mark)**
4. Which logic gate is similar to the function of two parallel switches? **(1 mark)**
5. Explain briefly, why one will consider an operational amplifier as an I.C. circuit? **(2 marks)**

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SCHEMATIC DIAGRAMS:

OBSERVATION (Record of Results):

RELEVANT THEORY:

ANSWER TO QUESTIONS:

CONCLUSIONS:

**MARK SCHEME**

<b>CRITERIA</b>		<b>Max. Mark</b>	<b>Teacher's Mark</b>	<b>CXC's Mark</b>
1.	Understanding relevant theory	2		
2.	Reading schematic/Setting-up test circuits	3		
3.	Answering questions	6		
4.	Observation (Record of Results)	2		
5.	Presentation	2		
6.	Conclusion/Reporting	2		
7.	Communication of information in a logical way using correct grammar	1		
	<ul style="list-style-type: none"><li>• Communicates information in a logical way using correct grammar and appropriate jargon of this field</li><li>• Communicates information that is not logical or jargon of the field</li></ul>			
TOTAL		18		