

FORM TP 2014066



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CARIBBEAN EXAMINATIONS COUNCIL
CARIBBEAN SECONDARY EDUCATION CERTIFICATE®
EXAMINATION

ELECTRICAL AND ELECTRONIC TECHNOLOGY

Paper 02 – Technical Proficiency

2 hours 40 minutes

13 MAY 2014 (p.m.)

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of **THREE** sections. Candidates **MUST** answer **NINE** questions.
SECTION A: You must answer **ALL FIVE COMPULSORY** questions from this section.
SECTION B: You must answer **THREE** questions from this section.
SECTION C: You must answer **ONE** question from this section.
2. You may use a silent, non-programmable calculator to answer questions.
3. All working must be **CLEARLY** shown.
4. Use sketches where necessary to support your answers.
5. You are advised to take some time to read through the paper and plan your answers.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

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Candidates **MUST** answer **NINE** questions: **ALL FIVE** from Section A, **THREE** from Section B and **ONE** from Section C.

SECTION A

Candidates **MUST** answer **ALL FIVE** questions in this section.

EACH question is worth **EIGHT** marks.

1. (a) (i) State the name given to the movement of electrons in an electric circuit. **(1 mark)**
- (ii) State the name of the force that produces the movement of electrons in an electric circuit. **(1 mark)**
- (iii) What is the relationship among the movement of electrons, the force that produces the movement of electrons and the opposition to the movement of electrons in an electric circuit? **(2 marks)**
- (b) Figure 1 shows the schematic drawing of an electric circuit.

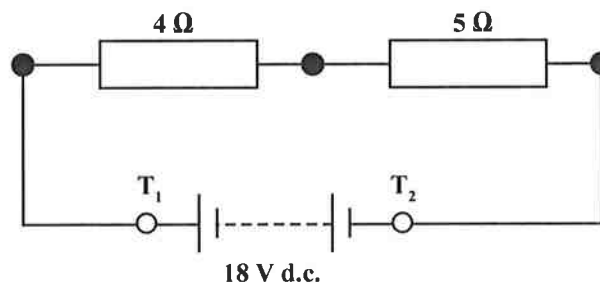


Figure 1. Schematic drawing of an electric circuit

- (i) Calculate the total opposition to the movement of electrons in the circuit in Figure 1. **(1 mark)**
- (ii) Calculate the magnitude of the movement of electrons in the circuit in Figure 1. **(1 mark)**
- (iii) Briefly explain a method to reverse the direction of movement of electrons in the circuit in Figure 1. **(2 marks)**

Total 8 marks

2. (a) (i) Name TWO instruments used to determine the 'level of charge' of a secondary cell. **(2 marks)**
- (ii) Name TWO types of primary cells used in products such as computers, watches and cameras. **(2 marks)**
- (b) Calculate the internal resistance of a primary cell with an open circuit terminal voltage of 1.5 V and a closed circuit terminal voltage of 1.0 V when the cell supplies a current of 0.5 A to an external circuit. **(4 marks)**

Total 8 marks

3. (a) (i) Name TWO devices/equipment used in an electric power station to convert primary energy to electric energy. **(2 marks)**
- (ii) State TWO methods of conversion of primary energy into electrical energy. **(2 marks)**
- (b) State the energy conversions that occur in an electric power station in which natural gas and steam-driven generators are used to produce electrical energy. **(4 marks)**

Total 8 marks

4. (a) (i) State the names of the control and positive terminals of a silicon-controlled rectifier. **(2 marks)**
- (ii) State TWO advantages of silicon-controlled rectifiers when used in switching circuits. **(2 marks)**
- (b) Figure 2 shows the schematic drawing of a silicon-controlled rectifier mains switching circuit.

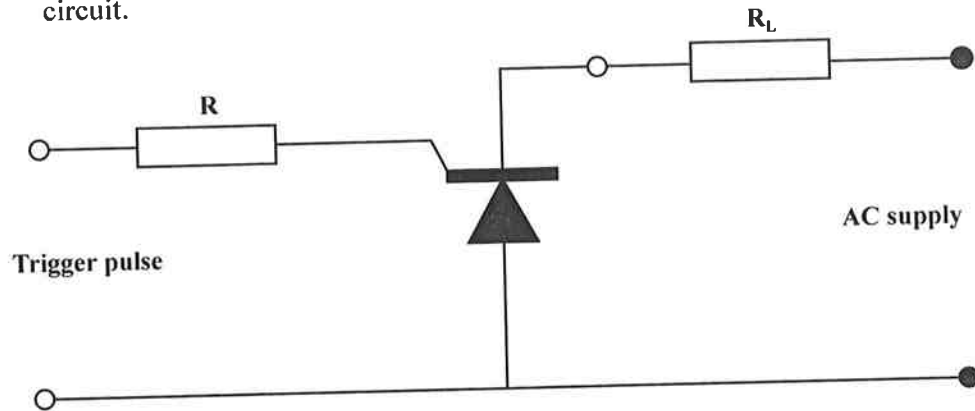


Figure 2. Schematic drawing of a silicon-controlled rectifier

Briefly explain the operation of the rectifier in the a.c. circuit.

(4 marks)

Total 8 marks

5. (a) (i) Name ONE impurity which is added to a pure semiconductor material to form a p-type semiconductor material. **(1 mark)**
- (ii) Name ONE impurity which is added to a pure semiconductor material to form an n-type semiconductor material. **(1 mark)**
- (iii) Name the TWO bias conditions of a semiconductor diode when it is connected in a half-wave rectifier circuit. **(2 marks)**
- (b) Figure 3 shows the schematic drawing of an npn transistor amplifier.

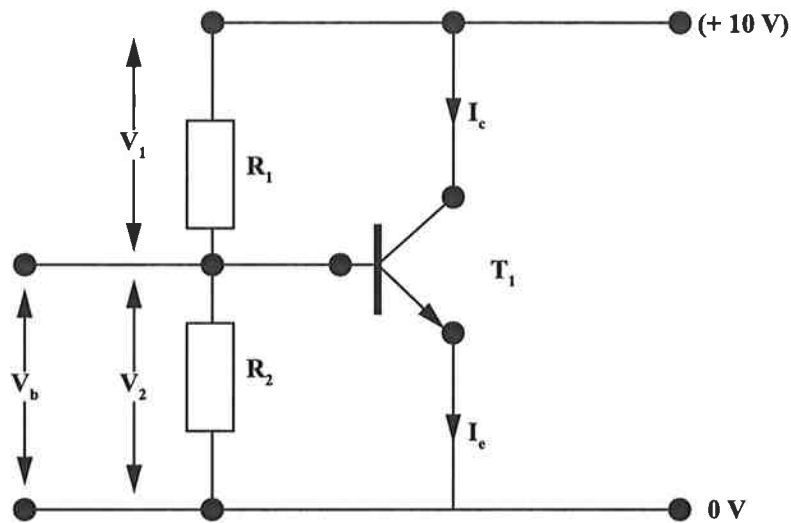


Figure 3. Schematic drawing of an npn transistor amplifier

Briefly explain the function of resistors, R_1 and R_2 , in the operation of the amplified circuit. **(4 marks)**

Total 8 marks

SECTION B

Candidates **MUST** answer **THREE** questions from this section.

Each question is worth 20 marks.

6. (a) (i) List **THREE** types of fixed resistor materials used in electronic circuits. **(3 marks)**
- (ii) State the names of **TWO** circuit components that can vary the electrical resistance in an electrical circuit. **(2 marks)**

(b) Figure 4 shows a schematic diagram of six resistors connected in series-parallel.

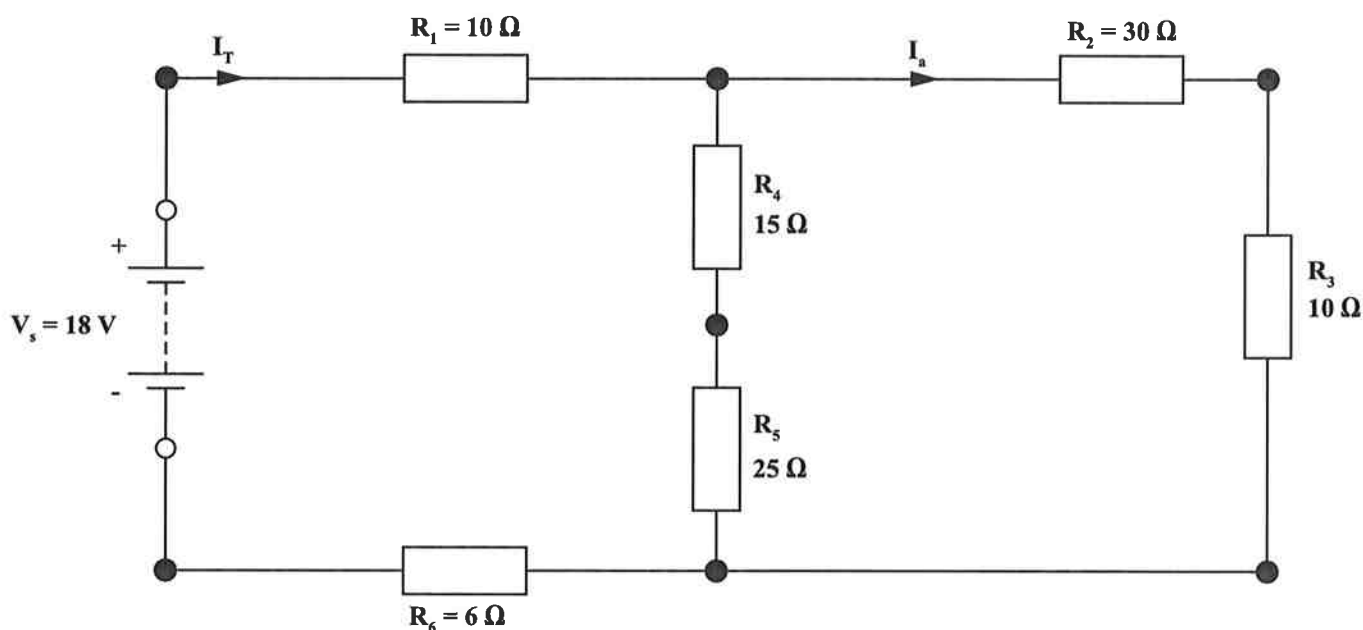


Figure 4. Schematic diagram of resistors connected in series-parallel

Calculate the

- (i) equivalent resistance of resistors R_2 , R_3 , R_4 and R_5 **(3 marks)**
- (ii) total resistance (R_T) of the circuit **(3 marks)**
- (iii) total current (I_T) flowing in the circuit **(3 marks)**
- (iv) current (I_a) flowing through resistor R_2 **(3 marks)**
- (v) drop in voltage across resistor R_3 . **(3 marks)**

Total 20 marks

GO ON TO THE NEXT PAGE

7. (a) (i) State the names of the TWO resistive effects in an inductive a.c. circuit. **(2 marks)**
- (ii) Name the TWO types of electrical power in an inductive a.c. circuit. **(2 marks)**
- (iii) State the name of ONE resistive component in an inductive a.c. circuit. **(1 mark)**
- (b) Figure 5 shows the circuit diagram of a resistor and an inductor connected in series to an a.c. supply.

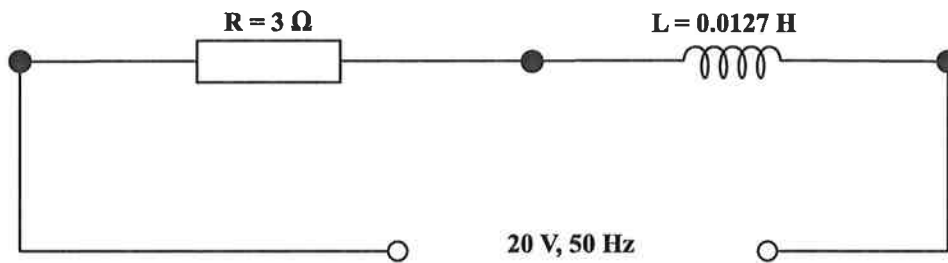


Figure 5. Resistor and an inductor connected in series

Calculate the

- (i) inductive reactance of the coil **(3 marks)**
- (ii) total opposition to a.c. current flow **(3 marks)**
- (iii) total current flowing in the circuit **(3 marks)**
- (iv) active power in the circuit **(3 marks)**
- (v) apparent power in the circuit. **(3 marks)**

Total 20 marks

8. (a) (i) State TWO operations which are carried out by the central processing unit of a computer. **(2 marks)**
- (ii) State TWO devices that are used to input data in a desktop computer system. **(2 marks)**
- (iii) State the function of software in a computer system. **(2 marks)**
- (iv) State the function of a surge protector in a computer's a.c. supply. **(2 marks)**
- (b) (i) Draw and name TWO logic gates other than the AND and the OR gates using standard symbols. **(4 marks)**
- (ii) State the Boolean expression for the output of a two-input AND gate. **(1 mark)**
- (iii) State the Boolean expression for the output of a two-input OR gate. **(1 mark)**
- (iv) Develop a truth table for a two-input AND gate. **(3 marks)**
- (v) Develop a truth table for a two-input OR gate. **(3 marks)**

Total 20 marks

9. (a) Figure 6 shows a one-line diagram of the electrical control equipment for a small factory.

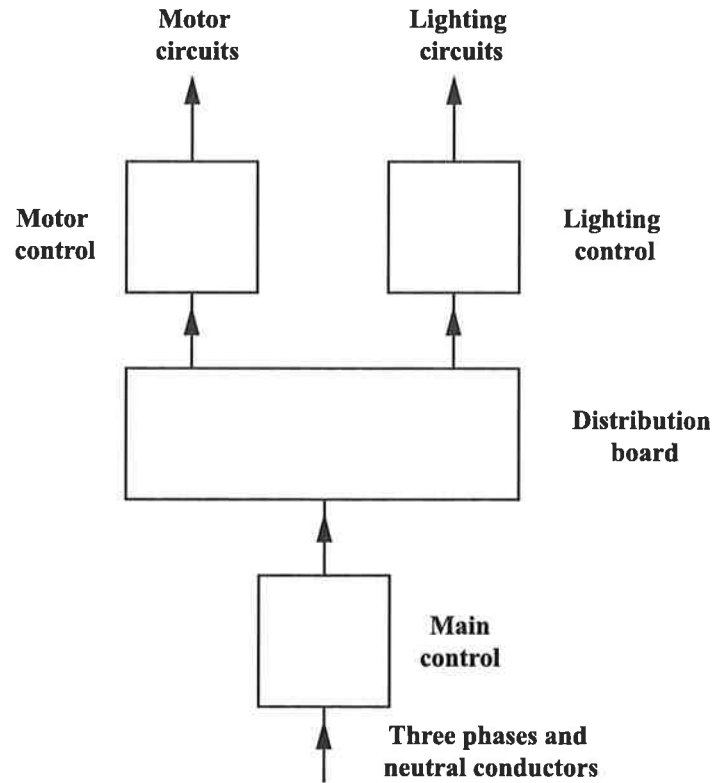


Figure 6. One-line diagram of electrical control equipment

- (i) State the phase/polarity arrangement of the a.c. supply in EACH of the following:
- Main control
 - Motor control
 - Lighting control **(3 marks)**
- (ii) Name TWO types of electrical devices that provide protection from damage by excess current in an electrical installation. **(2 marks)**
- (iii) State TWO methods used to reduce the START current of a three-phase induction motor. **(2 marks)**

- (b) A d.c. motor in a factory draws a load current of 30 A from a 240 V d.c. supply. The motor is in continuous operation over a thirty-day period. Calculate the
- (i) power developed by the motor **(3 marks)**
 - (ii) energy utilized by the motor during the thirty-day period **(3 marks)**
 - (iii) cost of operating the motor over the 30 days at 20¢/kWh. **(3 marks)**
- (c) Briefly explain how the earthing of exposed metal parts provides protection from electric shock in an electrical installation. **(4 marks)**

Total 20 marks

SECTION C

Candidates MUST answer ONE question from this section.

Each question is worth 20 marks.

10. (a) Figure 7 shows the schematic drawings of four rectifier circuits labelled (1), (2), (3) and (4).

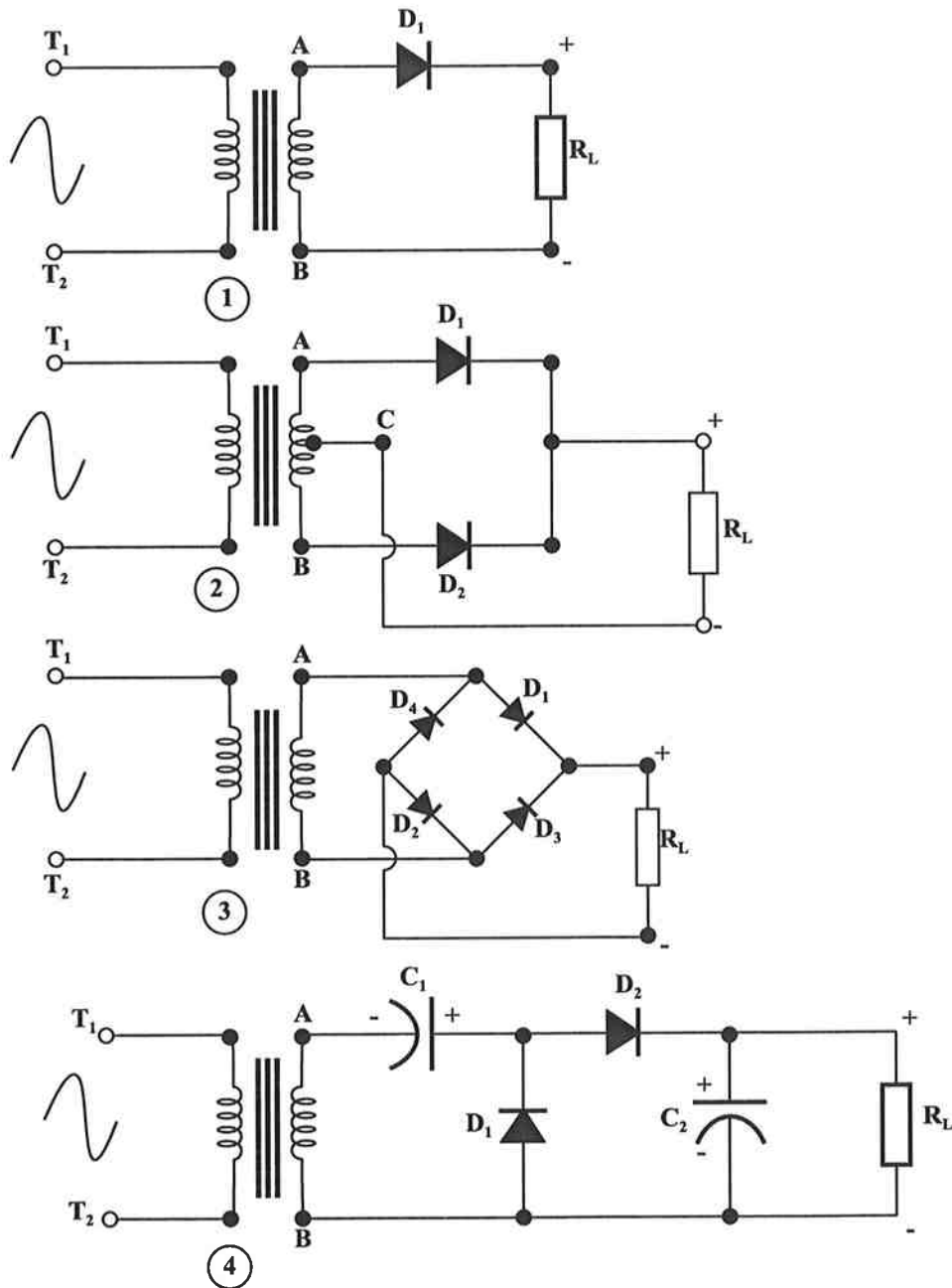


Figure 7. Schematic drawings of four rectifier circuits

- (i) In your answer booklet, write the numbers (1), (2), (3) and (4). Next to EACH number, write the name of the rectifier circuit indicated. (4 marks)
- (ii) Briefly explain the operation of the rectifier circuit labelled (2) in Figure 7. (4 marks)
- (iii) Briefly explain the operation of the rectifier circuit labelled (4) in Figure 7. (4 marks)

- (b) Figure 8 shows the schematic drawing of a low-voltage d.c. power supply unit. The components of the power supply are labelled (1), (2), (3), (4), (5) and (6).

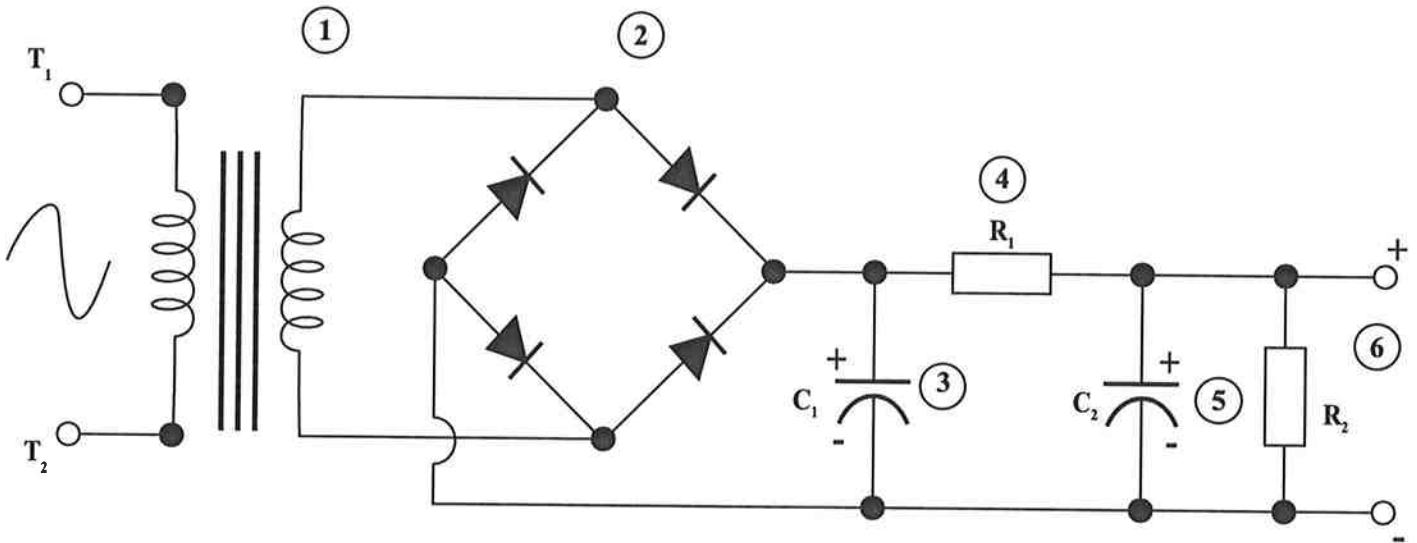


Figure 8. Schematic drawing of a low-voltage d.c. power supply unit

- (i) In your answer booklet, write the numbers (1), (2), (3), (4), (5) and (6). Next to EACH number, write the name of the electronic component indicated. (6 marks)
- (ii) Briefly explain the operation of the component labelled (3) in the schematic drawing in Figure 8. (2 marks)

Total 20 marks

11. (a) Figure 9 shows the schematic drawings of two single-phase a.c. motors labelled (A) and (B).

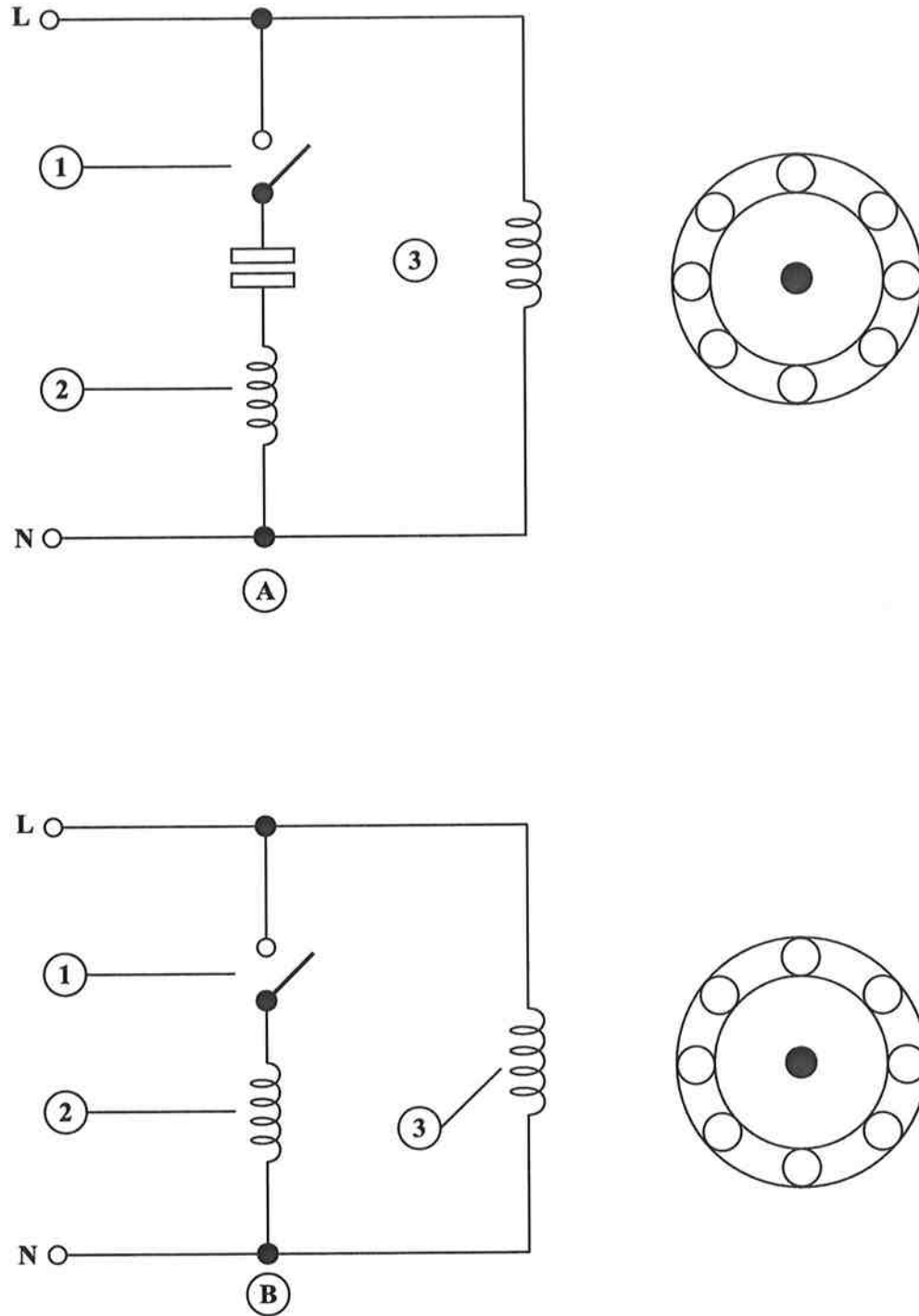


Figure 9. Schematic drawings of two single-phase a.c. motors

- (i) In your answer booklet, write the letters **(A)** and **(B)**. Next to EACH letter, write the name of the single-phase a.c. motor indicated. **(2 marks)**
- (ii) In your answer booklet, write the numbers **(1)**, **(2)** and **(3)**. Next to EACH number, write the name of the part of the a.c. motor indicated. **(3 marks)**
- (iii) Briefly explain how the rotating magnetic field effect is produced in the stator windings of the a.c. motor labelled **(A)**. **(3 marks)**
- (iv) Briefly explain the operation of the part labelled **(1)** in the control of current flow in the part labelled **(2)**, in the single-phase a.c. motors. **(2 marks)**

- (b) Figure 10 shows the schematic drawings of two three-phase a.c. motors labelled **(C)** and **(D)**.

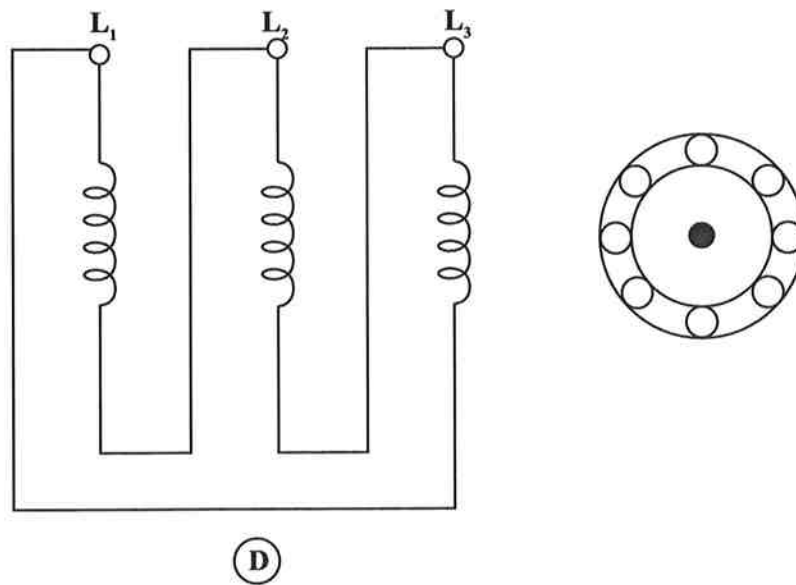
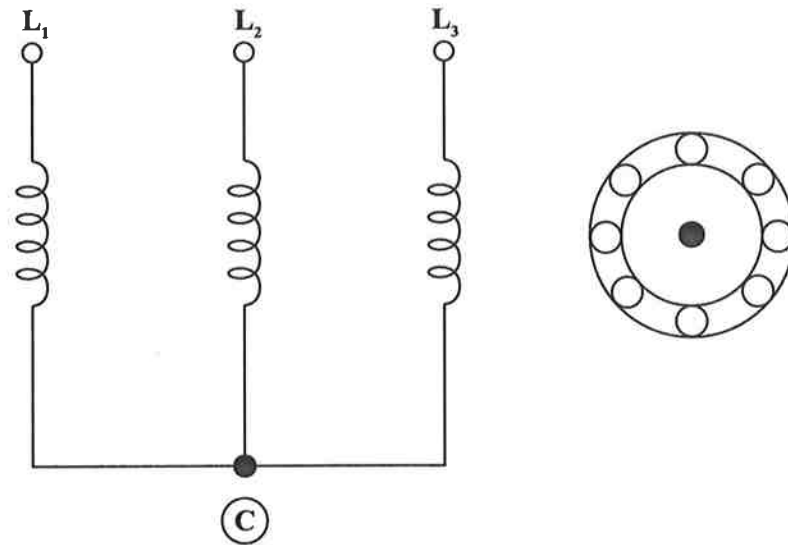


Figure 10. Schematic drawings of two three-phase a.c. motors

- (i) In your answer booklet, write the letters **(C)** and **(D)**. Next to EACH letter, write the name of the connection of the stator windings of the three-phase motor indicated. **(2 marks)**

- (ii) Define the following terms when applied to three-phase a.c. motors:
- Synchronous speed
 - Slip speed
 - Single-phasing **(3 marks)**
- (iii) Briefly explain the operation of a three-phase induction motor when supplied by a three-phase system. **(5 marks)**

Total 20 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.