TUTORIAL - BASIC ELECTRICAL CONCEPTS

NAME:

Please note the following requirements in relation to tutorial work -

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- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
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- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. A domestic electrician works in the:

   (a) Electrical Industry.

   (b) Electronics Industry.

   (c) Supply Industry.

   (d) Communications Industry

2. Electricity is transmitted at:

   (a) high voltage

   (b) low voltage

   (c) high current

   (d) high frequency

3. An example of the use of renewable energy is:

   (a) Pulverised Coal

   (b) LPG gas

   (c) Solar PV cells

   (d) Diesel fuel

4. An example of the use of non renewable energy is:

   (a) Wind
   (b) Natural Gas
   (c) Geo-thermal
   (d) Hydroelectric

5. Geysers are examples of   energy:

   (a) Tidal
   (b) Wind
   (c) Solar
   (d) Geothermal

6. Renewable energy sources:

   (a) Are constantly re-produced by the sun
   (b) Can easily transmitted over long distances
   (c) Are ideal as they all work 24/7 in all weather conditions
   (d) Harm the ozone layer

7. Most renewable energy sources can be traced back to:

   (a) The ozone layer
   (b) Hydro energy
   (c) Nuclear fission
   (d) Solar Energy

8. When coal is burnt to produce electricity a gas is produced that causes global warming. The gas is known as:-

   (a) Carbon dioxide.
   (b) Ozone.
   (c) Oxygen.
   (d) Methane.

9. The meter used to measure electric current in a circuit is a:

(a) ohmmeter
(b) voltmeter
(c) ammeter
(d) megger

10. The opposition to electric current is termed:

(a) amperes
(b) voltmeter
(c) residual
(d) resistance

11. The unit of electric current is the:

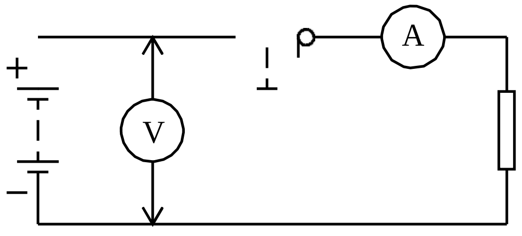
(a) ampere
(b) watt
(c) volt
(d) ohm

12. If the electric pressure applied to a circuit is increased with the resistance remaining constant electric current will:-

(a) remain the same
(b) decrease
(c) increase
(d) decrease to zero

13. This question refers to figure 24.. The ammeter method of connection is known as;

(a) short circuit connection
(b) series connection
(c) parallel connection
(d) open cir



14. This question refers to figure 24. The voltmeter method of connection is known as -

(a) parallel connection
(b) short circuit connection
(c) series connection
(d) open circuit connection.

15. This question refers to figure 24. Opening the switch in the circuit would have the effect of -

(a) reducing the circuit resistance.
(b) reducing the circuit voltage.
(c) increasing the circuit power.
(d) stopping the circuit current flow.

16. A battery provides a source of electrical -

(a) resistance.
(b) pressure
(c) displacement.
(d) conductor

17. The meter used to measure electrical pressure in a circuit is a;

(a) ohmmeter
(b) ammeter
(c) wattmeter.
(d) voltmeter.

SECTION B

18. (3 marks)

Draw the circuit diagram of a lamp supplied by a battery and controlled by a switch. Include an ammeter to measure the circuit current and a voltmeter to measure the battery voltage note the positive and negative terminals of the ammeter and voltmeter.

Convert the following values to both forms of engineering notation **WITHOUT using** a **calculator** (you will be able to use your calculator shortly)

Value	Engineering Notation using a power of 10 e.g. 34 x 10^{-6} Amps	Engineering Notation using a prefix e.g. 34 μA
32 000 Volts (V)		
600 000 000V0		
. 065 V		
0.230 V		
11,000 V		
133kV		
0.000076V		
0.4V		
0.000875mV		
375Amps (A)		
0.025MA		
8350 uA		
485000000000uA		
22500A		
0.09270mA		
0.0194A		
10.5A		
5544332211mA		
22500A		

TUTORIAL - BASIC ELECTRICAL CIRCUITS

NAME: ____________________

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- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The meter used to measure electric current in a circuit is a:

   (a) ohmmeter
   (b) voltmeter
   (c) ammeter
   (d) megger

2. The opposition to electric current is termed:

   (a) amperes
   (b) voltmeter
   (c) residual
   (d) resistance

3. The unit of electric current is the:

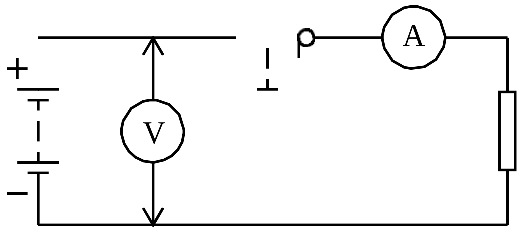
   (a) ampere
   (b) watt
   (c) volt
   (d) ohm

4. If the electric pressure applied to a circuit is increased with the resistance remaining constant electric current will:-

(a) remain the same
(b) decrease
(c) increase
(d) decrease to zero

5. This question refers to figure 24.. The ammeter method of connection is known as;

(a) short circuit connection
(b) series connection
(c) parallel connection
(d) open circuit



6. This question refers to figure 24. The voltmeter method of connection is known as -

(a) parallel connection
(b) short circuit connection
(c) series connection
(d) open circuit connection.

7. This question refers to figure 24. Opening the switch in the circuit would have the effect of -

(a) reducing the circuit resistance.
(b) reducing the circuit voltage.
(c) increasing the circuit power.
(d) stopping the circuit current flow.

8. A battery provides a source of electrical -

(a) resistance.
(b) pressure
(c) displacement.
(d) conductor

9. The meter used to measure electrical pressure in a circuit is a;

   (a) ohmmeter
   (b) ammeter
   (c) wattmeter.
   (d) voltmeter.

SECTION B

10. (3 marks)

    Neatly draw the circuit diagram for a lamp supplied by a battery and controlled by a switch. Include an ammeter to measure the circuit current and a voltmeter to measure the battery voltage note the positive and negative terminals of the ammeter and voltmeter.

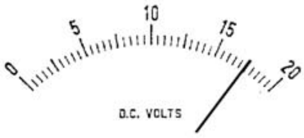
11. Draw the circuit diagram of a lamp supplied by a battery and controlled by a switch. Include a fuse to protect the circuit, an ammeter to measure the circuit current and a voltmeter to measure the battery voltage.

12. Determine the value and quantity measured on each of the following meters

(a)

(b)

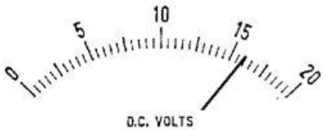
(c)



(d)

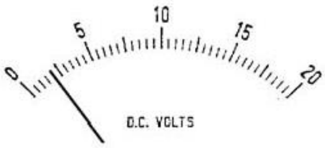
13. Determine the value and quantity measured on each of the following meters -

(a)



(b)

(c)



(d)

14. Convert the following number to both formats of Engineering Notation

Number	Convert to a multiple using a power of 10 eg 123×10^3	Convert using a prefix (letters only) 123kV
220000Volts		
844.4Volts		
0.034Volts		
0.008 Volts		
2380 micro Amps		
95 milli Amps		
2400 Amps		
6350 milli Amps		
40000 micro volts		
150000000 Amps		
0.00743258 Volts		
400545486 Amps		
1Volt		
0.194 milli Amp		

TUTORIAL - OHM'S LAW

NAME:

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- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. Ohm's Law is only true when:

   (a) the circuit consists of metallic conductors

   (b) current and voltage are unequal

   (c) the voltage exceeds the current

   (d) circuit conditions are unchanged

2. If the resistance of a circuit is doubled, the current will be:

   (a) the same.

   (b) doubled.

   (c) halved.

   (d) decreased

3. Using the principle of Ohm's Law the resistance of a circuit may be calculated using the equation:

   (a) $R = \frac{I}{V}$

   (b) $R = V.I$

(c) $R = \frac{V}{I}$

(d) R = V + I

4. If the resistance of a circuit is constant and the voltage applied to the circuit increased, the circuit current will:

   (a) fall to zero
   (b) decrease
   (c) increase
   (d) remain unchanged

5. If the voltage applied to a circuit is constant and the resistance of the circuit is increased, the circuit current will:

   (a) remain unchanged
   (b) fall to zero
   (c) decrease
   (d) increase

Section B:
Blank spaces in the following statements represent omissions. Write the appropriate information.

6. The current flowing in a circuit is____________proportional to the applied voltage and_____________proportional to the circuit resistance.

7. According to Ohm's Law, increasing the applied voltage causes the circuit current to ____________.

8. Ohm's Law only applies to resistors with linear characteristics provided the ____________ remains constant.

9. When applying Ohm's Law, the voltage applied to a circuit is equal to the product of the_____________and the______________.

SECTION C:

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places.

10. A circuit has an applied voltage of 20V and a resistance of 5Ω. Determine the circuit current. (4A)

11. A circuit has an applied voltage of 15V and draws a current of 3A. Determine the circuit resistance. (5Ω)

12. A circuit that has a resistance of 15Ω draws a current of 1.6A. Determine the applied voltage. (24V)

13. A circuit has an applied voltage of 240V and has a resistance of 5000Ω. Determine the circuit current. (0.048A)

14. A circuit has the following values: I = 0.15A R = 150Ω
Determine the applied voltage. (22.5V)

15. A circuit is connected to a DC power supply that is set to 12V. If the resistance of the circuit is 24 Ω determine the current flowing in the circuit. (0.5A)

16. Determine the DC voltage that must be applied to a circuit of 56 Ω resistance to cause a current of 0.5A to flow. (28V)

17. When a 12V battery is connected to a circuit a current of 0.025A flows. Determine the circuit resistance. (480Ω)

18. A circuit has a current flow of 1.5A when connected to a 12V battery. Determine the current that will flow if the same circuit is connected to a 15V battery. (1.875A)

19. A test is carried out on a circuit and the results tabulated as shown in table 3.

Table 3					
Applied Voltage volts	0	3	6	9	12
Circuit Current amperes	0	0.25	0.5	0.75	1

(a) Draw a graph of the test results using axis as shown in figure 25. Make each axis 100mm long.

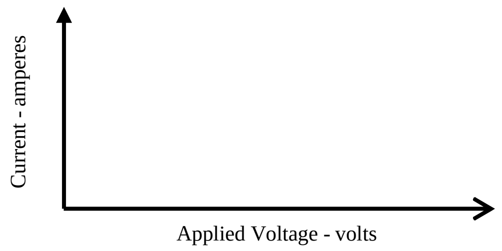


figure 25

(b) Indicate on your graph the value of current when the applied voltage is -

(i) 4V

(ii) 7.5V

(iii) 10.5V

(c) Is the graph linear or non-linear.

(d) From your graph determine the voltage applied when the circuit current was -

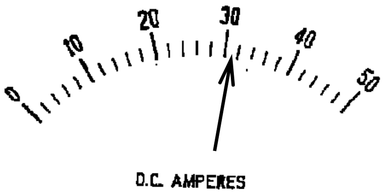
(i) 0.2A

(ii) 0.4A

(iii) 0.8A

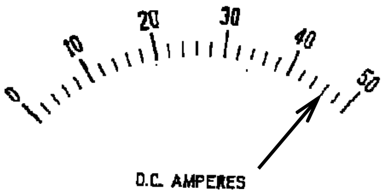
(e) Draw a circuit that will enable you to carry out the above test to achieve this set of test results. Fully label your circuit, including the value of resistance used.

20. Determine the value and quantity measured on each of the following meters -

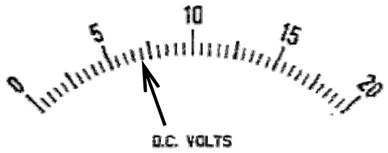


(a)

(b)



(c)



(d)

TUTORIAL - ELECTRICAL POWER

NAME :

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Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

The unit of both mechanical and electrical power is the:

(a) volt
(b) joule
(c) watt
(d) ampere

Power in an electrical circuit is measured using an instrument called the:

(e) wattmeter
(f) volt/ammeter
(g) kilowatt hour meter
(h) ammeter.

Two electrical instruments whose readings may be combined to determine circuit power are the:

(i) voltmeter and wattmeter
(j) ammeter and wattmeter
(k) ammeter and voltmeter
(l) wattmeter and kilowatt hour meter

Power is defined as the:

(m) rate at which work is done
(n) amount of energy required to do work.
(o) ability to do work
(p) heat dissipated when work is done

Electrical equipment is rated in terms of:

(q) voltage and resistance
(r) voltage and power
(s) voltage and current
(t) power and current.

Mechanical power and electric power are:

(u) in no way related to each other
(v) related by a factor of 9.81
(w) the same.
(x) measured using different units.

The current in a circuit that is consuming power can be calculated using the equation.

(y)(y) $I = \frac{V}{P}$

(z)(z) $I = \frac{V}{R}$

(aa) $I = P \times V$

(bb) $I = \frac{P}{V}$

If the voltage applied to a resistive circuit was doubled, the power dissipated would:

(cc) double.

(dd) decrease to a quarter of the original value.

(ee) halve.

(ff) increase to four times the original value.

If the voltage applied to a resistive circuit is halved, the power dissipated will:

(gg) double.

(hh) decrease to a quarter of the original value.

(ii) halve.

(jj) increase to four times the original value.

The greater the power taken by a circuit from the supply, the:

(kk) greater the heat dissipated.

(ll) lower the heat dissipated.

(mm) lower the work done.

(nn) cooler the circuit conductors

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

Two electrical instruments whose readings can be combined to determine the power dissipation of a circuit are the___________and___________.

A wattmeter consists of a____________coil connected in parallel with the supply and a _________ coil connected in series with the load.

An electric motor converts___________power to____________power.

The power dissipated by a resistor is given off in the form of ____________

Power is the____________at which work is done.

When connecting a wattmeter to measure the power taken by a circuit, the current coil is connected in____________with the load and the voltage coil in____________with the load.

The terminals of the current coil of a wattmeter are usually labelled____________and ___________, whereas the terminals of the voltage coil are usually labelled ____________ and_____________.

An electric radiator is rated at 1kW, this means the____________power to the radiator is 1000 watts.

An electric motor is rated at 5kW, this means the___________power from the motor is 5000 watts.

SECTION C

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

Convert the following quantities to the multiple or sub-multiple required:

0.005 watts to milliwatts (5mW)

130 milliwatts to watts (0.13W)

250 000 watts to kilowatts (250kW)

0.28 megawatts to watts (280 000W)

158 000 watts to kilowatts. (158kW)

A circuit has an applied voltage of 240V and a circuit current of 10A. Determine the circuit power dissipation. (2400W or 2.4 x 10^3W or 2.4kW)

A circuit has an applied voltage of 100V and a circuit current of 5A. Determine the power taken by the circuit. (500W)

A circuit has an applied voltage of 6V and has a resistance of 25kΩ. 1.Determine the circuit power dissipation. (0.00144W or 1.44mW or 1.44 x 10^{-3}W)

A circuit has the following values R = 12kΩ I = 2mA. Determine the power supplied. (0.048W or 48mW or 48 x 10^{-3}W)

Determine the power taken by a circuit that is supplied with a voltage of 110V and draws a current of 2.5A. (275W)

Determine the DC voltage that must be applied to a circuit of 625Ω resistance to cause a current of 160mA to flow. (100V)

When a 12V battery is connected to a circuit a current of 750mA flows. Determine the power supplied. (9W)

A circuit has a current flow of 5µA when connected to a 4.5V battery. Determine the power dissipated. (0.0000225W or 22.5µW or 22.5 x 10^{-6}W)

A circuit has a resistance of 1.5Ω and a current flow of 14A. Determine the power taken by the circuit. (294W)

Determine the power dissipated by a 27Ω resistor when connected to a 240V supply. (2133W or 2.133kW or 2.133 x 10^{3}W)

Draw the circuit diagram of a 12Ω resistor connected to a 240V supply. Include in your diagram a/an –

(oo) fuse

(pp) switch to control current flow

(qq) ammeter to measure circuit current

(rr) voltmeter to measure the applied voltage

(ss) wattmeter to measure circuit power consumption.

(tt) Determine the readings on all three meters.

(V = 240V, I = 20A, P = 4800W or 4.8kW)

TUTORIAL - EMF SOURCES

NAME:

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SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The magnitude of the emf produced by a photo-voltaic cell depends upon the:

   (a) size of the electrodes
   (b) material from which the electrodes are made
   (c) intensity of light to which it is exposed
   (d) number of positive and negative electrodes

2. The magnitude of the emf produced at the terminals of a secondary cell depends on the:

   (a) size of the electrodes
   (b) material from which the electrodes are made
   (c) intensity of light to which it is exposed
   (d) (h)number of positive and negative electrodes

3. The open circuit emf produced by a single dry cell is approximately:

   (a) 0.5V
   (b) 1.0V
   (c) 1.5V
   (d) 2.0V

4. A common device used to produce a small emf by having two different metals joined to form a junction is called a:

   (a) thermopile
   (b) thermocouple
   (c) piezoelectric cell
   (d) dry cell

5. Certain crystals when placed under mechanical stresses or vibration produce an emf. The effect is called the:

   (a) photoelectric effect
   (b) thermoelectric effect
   (c) piezoelectric effect
   (d) crystalelectric effect

6. A number of thermocouples connected so their emf's add together is termed a:

   (a) thermotank
   (b) multitherm
   (c) thermocouple bank
   (d) thermopile

7. The piezoelectric effect produces electrical energy from:

   (a) light energy
   (b) heat energy
   (c) mechanical energy
   (d) chemical energy

8. Generally speaking the physical size of a cell increases with:

   (a) increase in output current
   (b) decrease in output current
   (c) increase in output voltage
   (d) decrease in output voltage

9. All emf sources are forms of:

   (a) current generators
   (b) power converters
   (c) energy converters
   (d) charge storing devices

10. Solar cells are commonly used to power:

   (a) outback telephones
   (b) spacecraft
   (c) experimental electric cars
   (d) all of the above

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information.

11. The ....cell produces an emf when exposed to light.

12. The ....effect is used to produce an emf in a microphone.

13.are often embedded in the walls of furnaces to detect temperature changes.

14. An emf may be produced by the piezoelectric effect if a ....is vibrated.

15. A device called a......................is created where a difference of temperature exists between two junctions of dissimilar metals.

16. A secondary cell is one in which the chemical reactions are …………….

17. The emf per cell of a standard lead-acid battery is approximately ....volts.

18. The chemical reactions cannot be reversed in a..................... cell.

19. A generator produces an emf due to the relative motion between a .... and a magnetic field.

20. A thermopile consists of two or more...................... connected in series.

21. The electromagnetic effect is used by a.....................to produce an emf.

22. The photo-voltaic cell produces an emf when exposed to a ....source.

SECTION C

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

23. Convert the following quantities to the multiple or sub-multiple required:

(a)	0.005 ohms to microhms	(5000μΩ)
(b)	130 milliampers to amperes	(0.13A)
(c)	250 000 ohms to megohms	(0.25MΩ)
(d)	0.28 megavolts to kilovolts	(280kV)
(e)	158 000 volts to kilovolts.	(158kV)

24. A circuit has an applied voltage of 150V and a resistance of 12kΩ. Determine the circuit current. (12.5mA or 12.5 x 10^{-3}A)

25. A circuit that has a resistance of 50kΩ draws a current of 1.2mA. Determine the applied voltage. (60V)

26. The equivalent circuit of a battery consisting of 2 x 1.8 volt cells is shown in figure 20. Determine the

a) developed E.M.F (E)
b) voltage on internal resistance (V_{Ri})
c) terminal voltage (E).

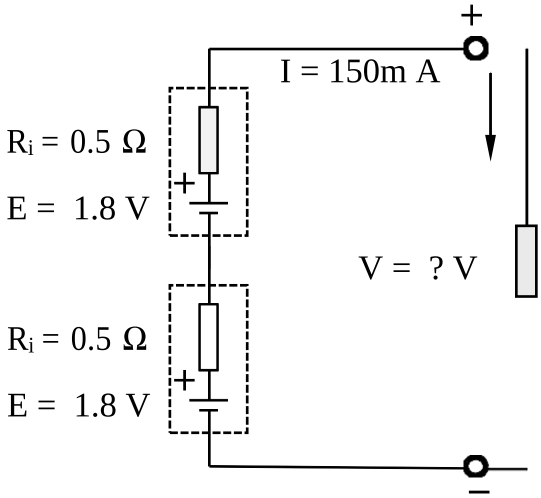

figure 20

27. Determine the voltage drop on resistor R_2 of figure 21. Use the voltage divider equation.

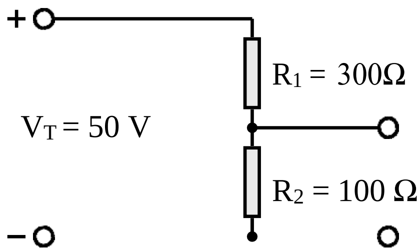

figure 21.

TUTORIAL – RESISTANCE AND RESISTANCE MEASUREMENT

NAME:

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SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. Resistors are rated by their value of resistance and the:

   (a) maximum voltage applicable
   (b) cross-sectional area of wire from which they are made
   (c) maximum current flow
   (d) power able to be safely dissipated

2. A light dependant resistor has a/an:

   (a) non-linear characteristic
   (b) linear characteristic
   (c) constant characteristic
   (d) inverse characteristic

3. A resistor whose resistance remains constant with changes in external conditions is said to have a/an:

   (a) non-linear characteristic.
   (b) linear characteristic
   (c) constant characteristic.
   (d) inverse characteristic

4. The resistance of a voltage dependant resistor at normal working voltages is:

   (a) very high.
   (b) very low.
   (c) determined by the circuit power dissipation.
   (d) determined by the current flow in the circuit

5. The preferred value of a 25000 Ω resistor with a 5 % tolerance is:

   (a) 22000 Ω.

(b) 24000Ω.
(c) 25000 Ω.
(d) 27000 Ω.

6. A 47 kΩ, 5% resistor would be indicated by the colour band order:

(a) violet, yellow, green, gold.
(b) yellow, violet, orange, gold.
(c) green, blue, red, silver.
(d) grey, red, green.

7. The number of units in one milli unit is one multiplied by:

(a) 10^6
(b) 10^3
(c) 10^{-3}
(d) 10^{-6}

8. The basic unit of resistance is the:

(a) mho
(b) siemen
(c) ohm
(d) ampere

9. The number of units in one micro unit is one multiplied by:

(a) 10^6
(b) 10^3
(c) 10^{-3}
(d) 10^{-6}

10. The standard unit for the measurement of time is the:

(a) minute.
(b) hour.
(c) second.
(d) milli second.

11. The number of units in one mega unit is one multiplied by:

(a) 10^6
(b) 10^3
(c) 10^{-3}
(d) 10^{-6}

12. The standard unit for the measurement of conductance is the:

(a) siemen.
(b) ohm.
(c) ampere.
(d) milli ohm.

13. The unit for the quantity of electricity is the:

(a) coulomb.
(b) volt.
(c) siemen.
(d) ampere.

14. A voltage of 1kV is equal to:

(a) 0.001V.
(b) 1×10^{-3}V
(c) 1000V
(d) 0.1V

Section B:
Blank spaces in the following statements represent omissions. Write the appropriate information.

15. The physical difference between a 100 Ω, 10W resistor and a 100 Ω, 1W resistor is its ____________.

16. The resistance of an LDR varies from a high value to a low value as the light falling on the resistor ___________.

17. Three common methods of construction of resistors are____________,___________ and_____________.

18. A resistor has a resistance of 470W, with a tolerance of 10%. The colour code for this resistor would be_____________,____________,_____________and___________.

19. A resistor has a resistance of 5R6W, with a tolerance of 1%. The colour code for this resistor would be_____________,____________,______________and___________.

20. A resistor with a gold fourth band would have a tolerance of____________.

SECTION C:

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

21. Using the resistor colour code, determine the resistance and tolerance of the resistor shown in figure 23. (2200 Ω, ±5%).

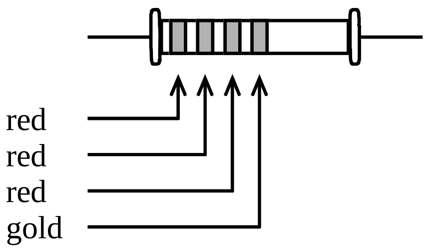


figure 23.

22. Using the resistor colour code, determine the resistance and tolerance of the resistor shown in figure 24. (680 Ω ±10%)

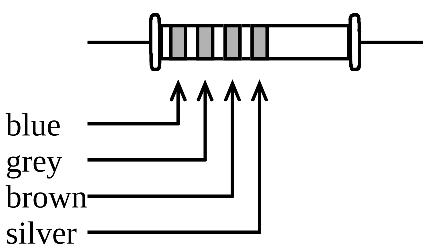


figure 24

23. A resistor has a power rating of 5W and a resistance of 470Ω. Determine the maximum voltage that could be applied to the resistor without exceeding its power rating. (48.47V)

24. Draw the Australian standard symbols for the voltage dependant resistor and the light dependant resistor.

25. Draw the characteristic curve for a light dependant resistor.

26. Draw the characteristic curve for a voltage dependant resistor.

27. List one application for each of the following devices:
    (a) light dependant resistor
    (b) voltage dependant resistor
    (c) thermistor.

TUTORIAL – RESISTANCE AND RESISTANCE MEASUREMENT

NAME:

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

28. Resistors are rated by their value of resistance and the:

    (a) maximum voltage applicable
    (b) cross-sectional area of wire from which they are made
    (c) maximum current flow
    (d) power able to be safely dissipated

29. A light dependant resistor has a/an:

    (a) non-linear characteristic
    (b) linear characteristic
    (c) constant characteristic
    (d) inverse characteristic

30. A resistor whose resistance remains constant with changes in external conditions is said to have a/an:

    (a) non-linear characteristic.
    (b) linear characteristic
    (c) constant characteristic.
    (d) inverse characteristic

31. The resistance of a voltage dependant resistor at normal working voltages is:

    (a) very high.
    (b) very low.
    (c) determined by the circuit power dissipation.
    (d) determined by the current flow in the circuit

32. The preferred value of a 25000 Ω resistor with a 5 % tolerance is:

    (a) 22000 Ω.
    (b) 24000Ω.
    (c) 25000 Ω.

(d) 27000 Ω.

33. A 47 kΩ, 5% resistor would be indicated by the colour band order:

(a) violet, yellow, green, gold.
(b) yellow, violet, orange, gold.
(c) green, blue, red, silver.
(d) grey, red, green.

34. The number of units in one milli unit is one multiplied by:

(a) 10^6
(b) 10^3
(c) 10^{-3}
(d) 10^{-6}

35. The basic unit of resistance is the:

(a) mho
(b) siemen
(c) ohm
(d) ampere

36. The number of units in one micro unit is one multiplied by:

(a) 10^6
(b) 10^3
(c) 10^{-3}
(d) 10^{-6}

37. The standard unit for the measurement of time is the:

(a) minute.
(b) hour.
(c) second.
(d) milli second.

38. The number of units in one mega unit is one multiplied by:

(a) 10^6
(b) 10^3
(c) 10^{-3}
(d) 10^{-6}

39. The standard unit for the measurement of conductance is the:

(a) siemen.
(b) ohm.
(c) ampere.
(d) milli ohm.

40. The unit for the quantity of electricity is the:

(a) coulomb.
(b) volt.
(c) siemen.
(d) ampere.

41. A voltage of 1kV is equal to:

(a) 0.001V.
(b) 1 x 10^{-3}V

(c) 1000V
(d) 0.1V

Section B:
Blank spaces in the following statements represent omissions. Write the appropriate information.

42. The physical difference between a 100 Ω, 10W resistor and a 100 Ω, 1W resistor is its ____________.

43. The resistance of an LDR varies from a high value to a low value as the light falling on the resistor ___________.

44. Three common methods of construction of resistors are____________,___________ and_____________.

45. A resistor has a resistance of 470W, with a tolerance of 10%. The colour code for this resistor would be______________,____________,_____________and___________.

46. A resistor has a resistance of 5R6W, with a tolerance of 1%. The colour code for this resistor would be______________,____________,______________and___________.

47. A resistor with a gold fourth band would have a tolerance of____________.

SECTION C:

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

48. Using the resistor colour code, determine the resistance and tolerance of the resistor shown in figure 23. (2200 Ω, ±5%).

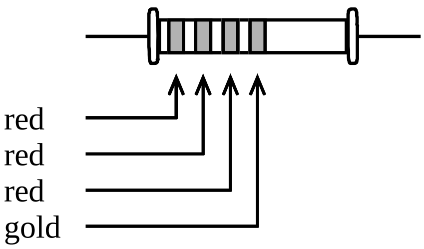


figure 23.

49. Using the resistor colour code, determine the resistance and tolerance of the resistor shown in figure 24. (680 Ω ±10%)

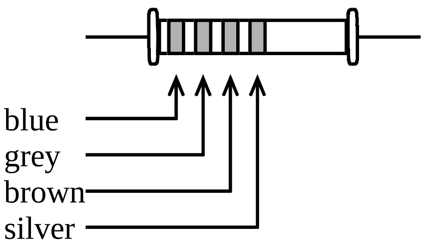


figure 24

50. A resistor has a power rating of 5W and a resistance of 470Ω. Determine the

maximum voltage that could be applied to the resistor without exceeding its power rating. (48.47V)

51. Draw the Australian standard symbols for the voltage dependant resistor and the light dependant resistor.

52. Draw the characteristic curve for a light dependant resistor.

53. Draw the characteristic curve for a voltage dependant resistor.

54. List one application for each of the following devices:
    (a) light dependant resistor
    (b) voltage dependant resistor
    (c) thermistor.

55. A circuit has a current flow of 15A when connected to a 24 V battery. Determine the current that will flow if the same circuit is connected to a 50 V battery. (31.25A)

____

____

____

____

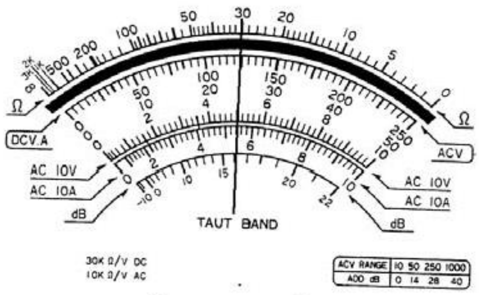
____

____

____

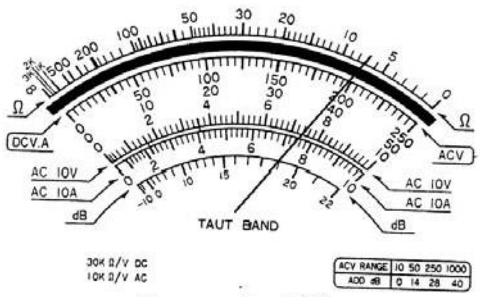
____

56. Determine the resistance values indicated on each of the meters shown.



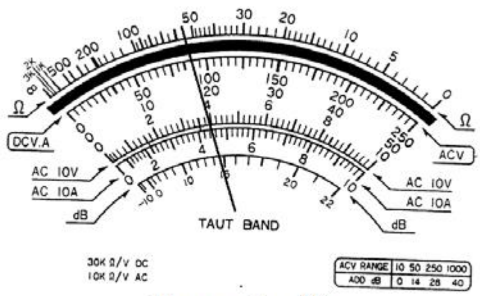
Range: Ω x 1

(a)

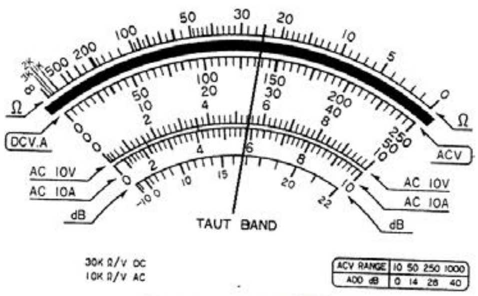


Range: Ω x 100

(b)



Range: Ω x 10



Range: Ω x 100

TUTORIAL - SERIES CIRCUITS

NAME:

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. In a series circuit the applied voltage is equal to the:

    (a) sum of the resistance times the current

    (b) sum of the resistance divided by the current

    (c) difference of the voltage drops across each resistor

    (d) sum of the resistances times the current squared

2. The current in a series circuit is:

    (a) equal to the sum of the currents in each component.

    (b) is proportional to the resistance of the circuit.

    (c) the same in all parts of the circuit.

    (d) decreases as it gets closer to the negative terminal of the supply.

3. Connecting resistors in series produces the same effect as increasing the:

    (a) supply voltage

    (b) cross-sectional area of resistance wire

    (c) length of resistance wire

    (d) supply current

4. When five lamps are connected in series and the third lamp burns out:

(a) lamps one and two go out, but four and five stay on
(b) all lamps except the third lamp remain on
(c) all lamps go out
(d) the fuse blows.

5. The current in a series circuit, consisting of three resistors of equal resistance, is 12A. If two resistors are short circuited the current will then be:

(a) 36A
(b) 4A
(c) 12A
(d) 0A

6. The voltage drop across each resistor in a series circuit is:

(a) equal to the product of current squared and resistance
(b) proportional to the conductance of each resistor
(c) inversely proportional to the supply voltage
(d) proportional to the resistance of each resistor

7. The total power in a series circuit may be determined by:

(a) multiplying total resistance of the circuit by current
(b) dividing supply voltage by total resistance
(c) subtracting total voltage drop from the supply voltage
(d) adding together the power taken by each component

8. Two resistors A and B are connected in series to a 200V supply. If resistor B has three times the resistance of A, the voltage drop across resistor B is:

(a) 200V
(b) 50V
(c) 150V
(d) 167V

9. A series circuit is defined as a circuit with:

(a) more than one current path
(b) only one current path
(c) more than one component
(d) more than one supply voltage

10. The equivalent resistance of a series circuit is determined by:

(a) the sum of the individual resistances
(b) the product of the individual resistances

(c) only by the use of Ohm's law

(d) the reciprocal of the sum of the reciprocals of the individual resistances

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information.

11. The current in all parts of a_________circuit has the same value.

12. If three cells each having an internal resistance of 0.4Ω are connected in series, the total internal resistance of the battery is_________ohms.

13. In a series circuit the sum of the voltage drops equals the_________.

14. Two lamps are connected in series across a 240V supply. The voltage across one lamp is 100V. The voltage across the second lamp would be_________.

15. The total power taken by a series circuit is equal to the_________of the powers taken by the individual components.

Questions 16 to 21 relate to figure 30

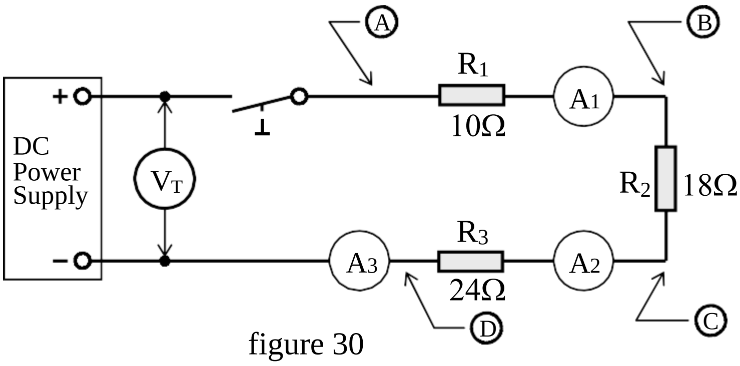


figure 30

16. The total resistance of a series circuit is equal to the_________of the individual resistances.

17. The reading on ammeter A1 will_________the reading on ammeter A3.

18. If the value of the resistor R_2 was decreased, the equivalent circuit resistance would _________.

19. With the switch in the open position, the voltage across the switch would equal ________.

20. Using the negative terminal of the power supply as a reference, complete the following statements

(a) the voltage at point A would be__________than the voltage at point C

(b) the voltage at point D would be__________than the voltage at point B

(c) the voltage at point C would be___________than the voltage at point D

(d) the voltage at point B would be__________than the voltage at point C.

21. The power dissipated by resistor R_2 would be __________ than the power dissipated by resistor R_1.

TUTORIAL - PARALLEL CIRCUITS

NAME:

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. In a parallel circuit the supply current is equal to the:

   (a) total power multiplied by the supply voltage
   (b) sum of the branch currents
   (c) supply voltage divided by the resistance of any one branch
   (d) ratio of the branch currents

2. Connecting resistors in parallel produces the same general effect as:

   (a) increasing the temperature of a metallic conductor
   (b) increasing the cross-sectional area of a conductor
   (c) increasing the length of a conductor
   (d) decreasing the conductance of a conductor.

3. When three 10Ω resistors are connected in parallel to each other, the voltage drop across each is:

   (a) one third of the supply voltage
   (b) supply voltage divided by 10
   (c) equal to the supply voltage
   (d) supply voltage divided by 30.

4. The lowest value of resistance in any parallel combination of resistors is always:

   (a) equal to the equivalent resistance of the combination.
   (b) less than the equivalent resistance of the combination.
   (c) dependent on voltage and current for its resistance.
   (d) greater than the equivalent resistance of the combination.

5. Twenty five resistors each with a resistance of 100 Ω are connected in parallel with each other. The equivalent resistance of the combination is:

   (a) 100 Ω
   (b) 2500 Ω
   (c) 4 Ω
   (d) 25 Ω

6. A parallel circuit is defined as a circuit with:

   (a) more than one resistor
   (b) more than one current path
   (c) only one current path
   (d) more than one supply voltage

7. If an extra parallel connected resistor is added to a circuit, the equivalent resistance of the circuit will:

   (a) increase
   (b) remain unchanged
   (c) decrease
   (d) cause the applied voltage to increase.

8. The voltage in a parallel circuit:

   (a) is the same in all parts of the circuit
   (b) decreases through the circuit from resistor to resistor
   (c) greater than the supply voltage
   (d) increases with increase resistance.

9. If one resistor in a parallel circuit of three resistors becomes short circuited, the circuit current will:

   (a) remain constant
   (b) decrease to zero
   (c) decrease by the value of current in the shorted branch
   (d) increase to a large value

10. The power dissipation of a parallel circuit is equal to the:

   (a) sum of the power dissipation of each branch
   (b) product of the power dissipation of each branch
   (c) difference of the power dissipation of each branch
   (d) power dissipation of each branch divided by the number of branches

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

11. Two electrical instruments whose readings can be combined to determine the power dissipation of a circuit are the …………….. and ....meters..

12. When resistances are connected in parallel, the equivalent resistance of the group is always, ...than that of the smallest individual value of resistance in the group.

13. The current taken by a parallel circuit is equal to the .... of the currents in the separate branches.

14. The voltage across parallel branches of a parallel circuit is........................the supply voltage.

15. To lower the equivalent resistance of a circuit, further resistance may be connected in …………….. with the original circuit.

16. The total power taken by a parallel circuit is equal to the .... of the powers taken by the individual branches.

17. Two lamps are connected in parallel. The filament of the first lamp open circuits, the second lamp would ……………...

Questions 18 to 17 relate to figure 22.

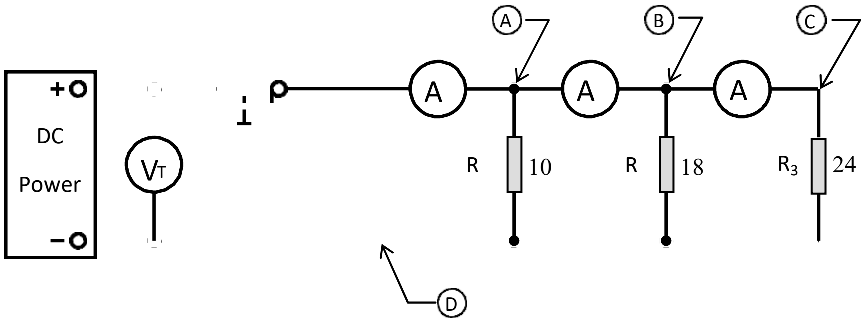


figure 22.

18. The reading on ammeter A_1 will be .... than the reading on ammeter A_3.

19. If the value of the resistor R_2 was decreased, the equivalent circuit resistance would ……………...

20. With the switch in the open position, the voltage across the switch would equal ……………...

21. Using the negative terminal of the power supply as a reference, complete the following statements

(a) the voltage at point A would .... the voltage at point C

(b) the voltage at point D would be ....than the voltage at point B

(c) the voltage at point C would be........................ than the voltage at point D

(d) the voltage at point B would.........................the voltage at point C.

22. The power dissipated by resistor R_2 would be......................... than the power dissipated by resistor R_1.

23. If resistor R_1 became open circuit, the equivalent resistance of the circuit would be ……………...

24. If resistor R_3 became short circuit, the circuit current would ....and the power dissipation would ……………...

SECTION C

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

25. Determine the equivalent resistance for the circuit shown in figure 2. (51.16Ω)
26. Determine the current flowing in R_1, R_2, R_3 and from the power supply in the circuit of figure 2 if the supply voltage is 12V. (0.1A, 0.08A, 0.055A, 0.235A)

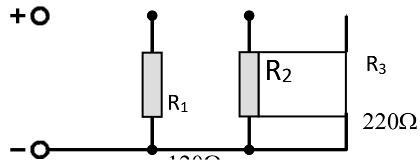


figure 23.

27. Determine the supply voltage for the circuit of figure 23 if the total current flowing in the circuit was 0.586A (30V)

28. For the circuit of figure 24 determine the -

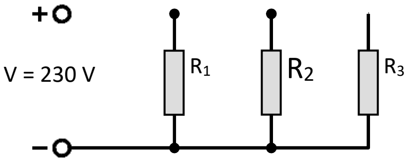


figure 24.

(a) equivalent resistance. (5 Ω)

(b) current in each branch (19.2A, 11.5A, 15.33A)

(c) supply current (46A)

(d) power dissipated by each branch (4408W, 2645W, 3526W)

(e) total power dissipation (10580W)

29. A circuit is made up of two resistors in parallel and has an equivalent resistance of 15.23 Ω. If R_1 has a resistance of 25 Ω, determine the resistance of R_2. (39 Ω)

30. For the circuit of figure 25 determine -

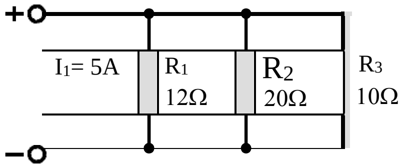


figure 25.

(a) equivalent resistance. (4.29 Ω)

(b) applied voltage. (60V)

(c) current in R_2 and R_3 (3A, 6A)

(d) supply current. (14A)

(e) power dissipated in each branch. (300W, 180W, 360W)

(f) total power dissipated. (840W)

TUTORIAL - SERIES PARALLEL CIRCUITS

NAME:

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- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The voltages in the parallel section of a series-parallel circuit:

   (a) are affected by the circuit equivalent resistance

   (b) are difficult to determine

   (c) are the same across the parallel components

   (d) decrease through the circuit from component to component

2. If one resistor in the parallel section of a series-parallel circuit goes open circuit, the circuit power dissipation will:

   (a) remain constant.

   (b) decrease.

   (c) increase.

   (d) decrease to zero.

3. The power dissipation of any circuit:

   (a) equal to the sum of the power dissipation of each resistor.

   (b) equal to the product of the power dissipation of each resistor.

   (c) equal to the supply voltage squared times the circuit equivalent resistance.

   (d) depends on the circuit arrangement.

4. In the circuit of figure 12, the supply current is equal to the:

(a) value of branch currents.

(b) product of the branch currents.

(c) sum of the currents in each resistor.

(d) sum of the branch currents.

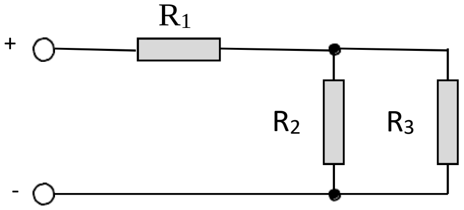

figure 12.

5. If the resistor R_1 in the circuit of figure 12 were to open circuit, the circuit current would:

(a) remain unchanged.

(b) decrease.

(c) increase.

(d) become zero.

6. If the resistor R_3 in the circuit of figure 12 were to short circuit, the circuit current would:

(a) decrease.

(b) become zero.

(c) increase.

(d) remain unchanged.

7. If the resistor R_2 in the circuit of figure 12 were to open circuit, the circuit power dissipation would:

(a) become zero.

(b) remain unchanged.

(c) decrease.

(d) increase.

8. If the resistor R_1 in the circuit of figure 12 were to short circuit, the circuit power dissipation would:

(a) become zero.

(b) remain unchanged.

(c) decrease.

(d) increase.

9. If an extra resistor was added in parallel with resistors R_2 and R_3 in the circuit of figure 12, the equivalent circuit resistance would:

(a) increase.

(b) decrease to zero.

(c) decrease to a lower value.

(d) increase to a much higher value.

10. If the resistance of the resistor R_1 in the circuit of figure 12 was to be increased, the equivalent resistance of the circuit would:

(a) increase.

(b) decrease to zero.

(c) decrease to a lower value.

(d) increase to an infinite value

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information. **Questions 11 to 27 relate to figure 13.**

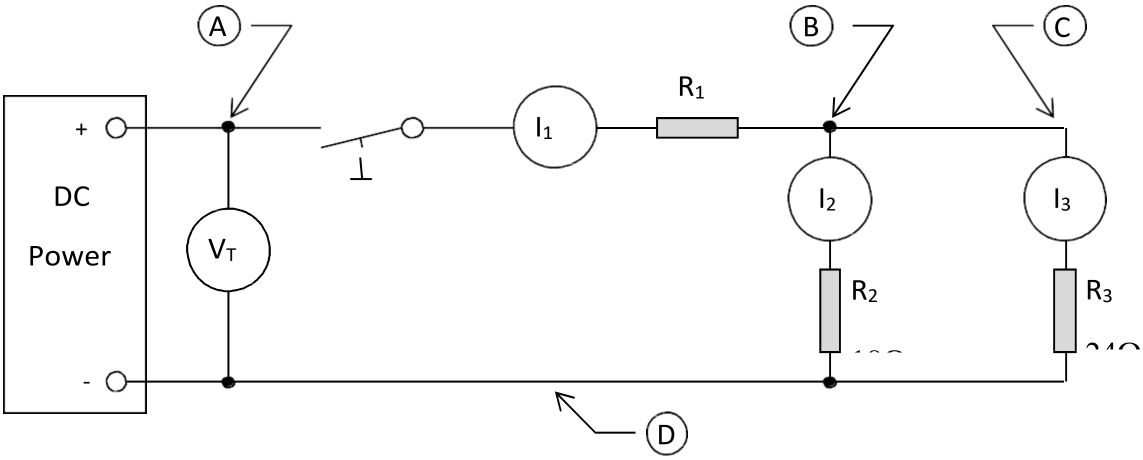

figure 13.

11. **Using the negative terminal of the power supply as a reference**, compare as either 'greater than', 'less than' or 'equal to' the voltages at the following points.

(a) the voltage at point A would be_______________the voltage at point C

(b) the voltage at point D would be_______________the voltage at point B

(c) the voltage at point D would be_______________the voltage at point A

(d) the voltage at point B would be_______________the voltage at point C.

12. Compare as either **'greater than'**, **'less than'** or **'equal to'** the currents at the following points.

   (a) the current through ammeter I_1 would be____________the current through ammeter I_2.

   (b) the current through ammeter I_3 would be____________the current through ammeter I_2.

   (c) the current through ammeter I_3 would be___________the current through ammeter I_1.

   (d) the current through ammeter I_1 would be_________the current at point D.

   (e) the current at point D would be_________the current through ammeter I_3.

   (f) the current in ammeter A2 would be___________the current at point D.

   (g) The power dissipated by resistor R_3 would be__________than the power dissipated by R_2.

13. If the value of the resistor R_2 was increased, the equivalent circuit resistance would ____________.

14. With the switch in the open position, the voltage across the switch would equal ________.

15. The power dissipated by resistor R_2 would be ________ than the power dissipated by resistor R_1.

16. If resistor R_1 became open circuit, the equivalent resistance of the circuit would be ________.

17. If resistor R_3 became short circuit, the circuit current would_________and the power dissipation would_________.

SECTION C

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

18. Determine the equivalent resistance for the circuit shown in figure 13. (20.29Ω)

19. For the circuit of figure 14, determine the -

(a) equivalent circuit resistance (209.19Ω)
(b) circuit current (0.478A)
(c) voltage drop across resistor R_1 (57.36V)
(d) voltage drop across R_2 and R_3 (42.63V)
(e) currents in resistors R2 and R3 (0.284A, 0.193A)
(f) total power dissipated (47.8W)

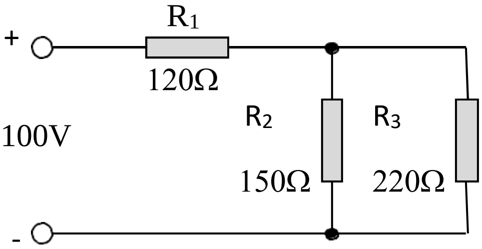

figure 14

20. For the circuit of figure 15, determine the –

(a) equivalent resistance (8.94Ω)
(b) current in each branch (19.17A, 6.57A)
(c) supply current (25.72A)

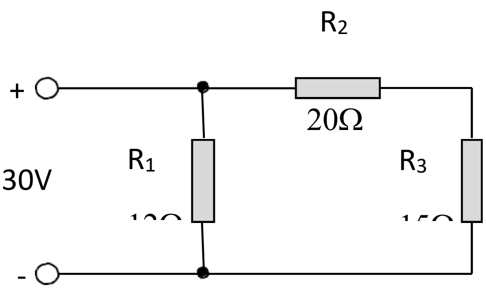

figure 15.

(d) power dissipated by each component (4408W, 863.3W, 647.47W)

(e) total power dissipation (5915.6W)

21. A circuit is made up of two resistors in parallel and has an equivalent resistance of 15.23Ω. If R_1 has a resistance of 25Ω determine the resistance of R_2. (39Ω)

TUTORIAL – RESISTANCE 2 AND FACTORS AFFECTING RESISTANCE

NAME:

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. If all other factors remain constant, the conductor having the least resistance would be:

   (a) $1mm^2$

   (b) $2.5mm^2$

   (c) $4mm^2$

   (d) $6mm^2$

2. If all other factors remain constant while the length of a conductor is halved, the resistance of the conductor is:

   (a) doubled.

   (b) squared

   (c) halved

   (d) quartered

3. The resistivity of a material:

   (a) varies directly with length

   (b) varies inversely with cross-sectional area

   (c) varies directly with cross-sectional area.

   (d) does not vary.

4. The unit of resistivity is the:

   (a) ohm.

   (b) volt-ampere.

   (c) ampere-metre.

(d) ohm-metre.

5. If all other factors remain constant while the cross-sectional area of the conductor is halved, the resistance of the conductor will be:

   (a) doubled.

   (b) squared.

   (c) halved.

   (d) quartered.

6. The element of an electric radiator is most likely to be wound with:

   (a) copper.

   (b) aluminium.

   (c) nichrome.

   (d) manganin.

7. Doubling the length of a $1.5mm^2$ copper conductor will cause the resistance of the conductor to:

   (a) halve.

   (b) double.

   (c) remain unchanged.

   (d) quadruple.

8. The resistance of a conductor is said to be:

   (a) proportional to its length.

   (b) inversely proportional to its length.

   (c) proportional to its cross-sectional area.

   (d) inversely proportional to its resistivity.

9. If all other factors remain constant while the length of a conductor is halved, the resistance of the conductor is:

   (a) doubled.

   (b) squared

   (c) halved

   (d) quartered

10. If all other factors remain constant while the cross-sectional area of the conductor is halved, the resistance of the conductor will be:

    (a) doubled.

    (b) squared.

    (c) halved.

    (d) quartered.

11. A material with a negative temperature coefficient of resistance would be:

(a) steel

(b) copper

(c) carbon

(d) manganin

12. As the temperature of an insulating material increases, its resistance:

(a) increases

(b) decreases

(c) remains unchanged

(d) reaches a maximum

13. If the resistance of a conductor increases with an increase in temperature, the conductor is said to have:

(a) a positive temperature coefficient of resistance

(b) a negative temperature coefficient of resistance

(c) a zero temperature coefficient of resistance

(d) no temperature coefficient of resistance

14. When the temperature of a metal conductor is increased, its resistance:

(a) remains constant

(b) increases

(c) decreases

(d) increases initially, then decreases.

15. Which of the following materials have a negative temperature coefficient of resistance:

(a) electrolytes and gases.

(b) metals and electrolytes.

(c) gases and metals.

(d) metals, gases and electrolytes.

Section B:
Blank spaces in the following statements represent omissions. Write the appropriate information.

16. The three physical factors that affect the resistance of a conductor are the ………………………..….. from which the conductor is made, its …………………..and its ………………………..

17. In circuits of long cable runs, larger conductors are used to ………………………..cable voltage drop.

18. The resistance of a circuit is measured in..................................... , whereas the resistivity of a conductor is measured in ………………………..

19. Carbon has a ....temperature coefficient of resistance.

20. The amount of change in each ohm of the initial resistance of a material per degree of temperature change is termed the......................................of resistance.

21. A temperature rise in a copper conductor also causes ………………………..in its resistance.

22. If tungsten is heated, its resistance ………………………..

23. The resistance of all pure metals ………………………..with an increase in temperature.

24. The temperature coefficient of a material is measured in___________________.

25. The abbreviation NTC stands for ___________ ___________ ____________.

26. The abbreviation PTC stands for ___________ ___________ ____________.

SECTION C:

The following problems are to be solved with the aid of a calculator. Answers are to be correct to two (2) decimal places. All equations and working are to be shown.

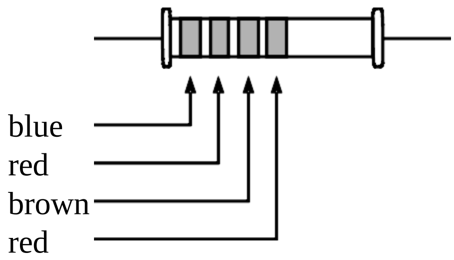

figure 11.

27. Using the resistor colour code, determine the resistance and tolerance of the resistor shown in figure 11. (620 Ω, ±2%).

28. Determine the resistance of a 200 metre length of $0.65mm^2$ aluminium conductor. The resistivity of aluminium is 2.6×10^{-8}Ωm. (8Ω)

29. Determine the cross-sectional area of a 100m length of conductor having a resistance of 80mΩ. The resistivity of the conductor is 1.72 x 10-8Ωm. ($21.5mm^2$)

30. Determine the resistance of a 30m run of $16mm^2$ copper conductor. The resistivity of copper is 1.72×10^{-8}Ωm. (0.0323Ω)

31. Determine the resistance of a 30m run of $2.5mm^2$ copper conductor. The resistivity of copper is 1.72×10^{-8}Ωm. (0.206Ω)

32. What length of $2.5mm^2$ copper conductor is required to make a resistance of 1.2Ω. Take the resistivity of copper to be 1.72×10^{-8}Ωm. (174.4m)

33. The circuit of a 240V, 4.8kW hot water service is shown in figure 11. The water heater is located 23m from the switchboard. The circuit was wired using $4mm^2$ copper, twin and earth. Determine the:

(a) resistance of the active conductor, given the resistivity of copper is $1.72 \times 10^{-8} \Omega m$ (0.0989Ω)

(b) voltage drop across the active conductor, given the circuit current is 20A. (1.978V)

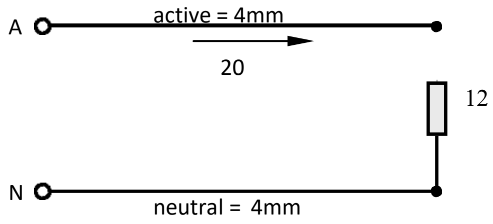

figure 11

TUTORIAL – METERS

NAME:-

Please note the following requirements in relation to tutorial work -

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- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

2. An increase in the size of a cable supplying a fixed load will cause the voltage drop on that cable to:

   (a) decrease

   (b) increase

   (c) stay the same

   (d) continually change.

3. The best material for an ammeter shunt would be:

   (a) copper

   (b) aluminium

   (c) manganin

   (d) carbon

4. The voltmeter sensitivity or the resistance of a voltmeter is given in terms of:

   (a) volts per ohm

   (b) ohms per volt

   (c) volts per ampere

   (d) ampere per volt.

5. The basic moving coil meter movement can be used to measure larger currents if used in conjunction with a:

   (a) shunt resistor
   (b) multiplier resistor
   (c) series resistor
   (d) loading resistor.

6. The basic moving coil meter movement can be used to measure higher voltages if used in conjunction with a:

   (a) shunt resistor
   (b) multiplier resistor
   (c) parallel resistor
   (d) loading resistor.

7. A voltmeter has an accuracy of 1% at a full range scale of 300 V. If the meter is reading 300 V the actual voltage value could be between:

   (a) 299-301V
   (b) 200 - 400 V
   (c) 291 V
   (d) 297 - 303V

8. An Ammeter has an accuracy of ∓ 2% at a full range scale of 100 A. If the meter is reading 100 A the actual current value could be between:

   (a) 99 – 101 A
   (b) 102 A
   (c) 98 – 102 A
   (d) 96 – 98 A

9. Referring to figure 16. The purpose of S_1, R_1, R_2 and R_3 is to:

   (a) extend the range of the ammeter
   (b) short out the ammeter
   (c) be used as a multiplying resistance
   (d) load the circuit.

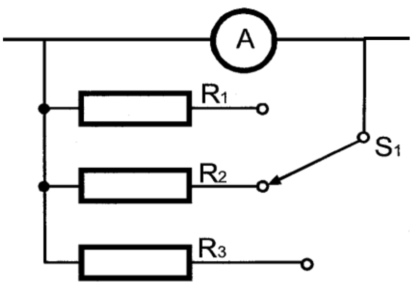


figure 16.

10. The resistance material used to extend the range of an ammeter should be made of a material which has the characteristics of a:

(a) Voltage Dependent Resistor

(b) Negative Temperature Coefficient resistor

(c) Zero Temperature Coefficient resistor.

(d) Positive Temperature Coefficient resistor.

11. If a voltmeter has low sensitivity, this means the voltmeter is:

(a) very accurate

(b) not accurate

(c) more likely to load the circuit.

(d) not sensitive to voltage changes

12. The question refers to figure 17 The current flowing in resistor R_{sh} is

(a) 1 mA

(b) 6 mA

(c) 8 mA

(d) 14 mA.

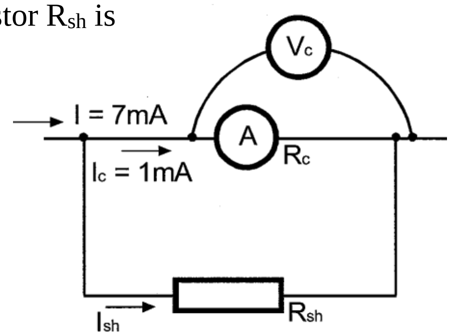


figure 17

13. Referring to figure 17. The voltage drop across resistor Rsh is equal to:

(a) Ic x Rsh

(b) Ic x Rc

(c) Ish x Rc

(d) I x Rsh

14. An AVO-7 multimeter has a sensitivity of 500 ohms/volt. Determine the resistance of the meter when used on the:

(a) 25 V range

(b) 1000 V range.

15. Referring to figure 18. Determine the:

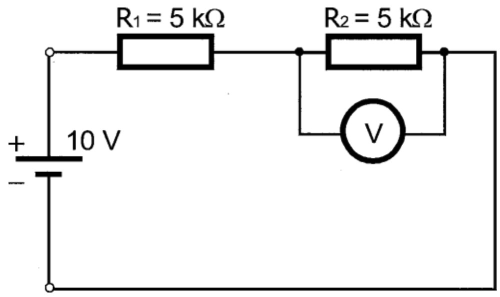


figure 18

(a) voltage across R_2

(b) voltage across R_2 if the voltmeter has a resistance of 20 MΩ

16. Question 15 refers to figure 19, determine:

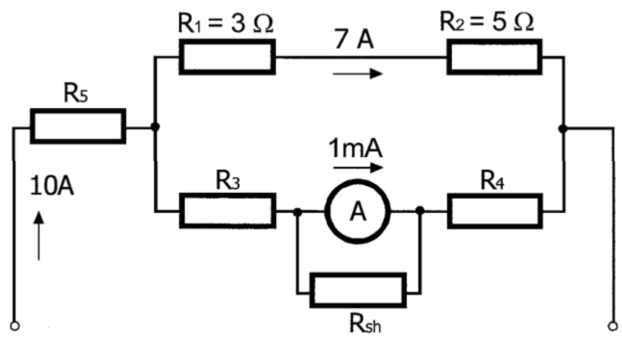


figure 19

(a) the value of the current through Rsh.

(b) the voltage drop across R_2

(c) the power rating of R_1

TUTORIAL - CAPACITORS AND CAPACITANCE

NAME: ____________________

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pagesstapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answerletter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation typequestions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifyingletter on your answer sheet.

1. Capacitors are classified by the material used in their:

   (a) plates.

   (b) dielectric.

   (c) electrodes.

   (d) casing.

2. The unit of capacitance is the:

   (a) coulomb

   (b) henry

   (c) farad

(d) ohm

3. A device used for storing electric charge is the:

   (a) resistor

   (b) inductor

   (c) capacitor

   (d) reactor

4. Decreasing the dielectric thickness of a capacitor:

   (a) increases the capacitance

   (b) increase the voltage it will withstand

   (c) decreases its capacitance

   (d) has no effect on its capacitance.

5. Which of the following cannot be used as a dielectric:

   (a) air

   (b) paper

   (c) carbon

   (d) polyester

6. Decreasing the plate area of a capacitor:

   (a) increases its capacitance

   (b) does not effect its capacitance

   (c) decreases its capacitance

   (d) increases its dielectric strength

7. Increasing the capacitance in an R-C circuit will cause the time constant to:

   (a) remain the same

   (b) increase

   (c) decrease

   (d) reach a maximum value on charging

8. In an R-C circuit, after a period of one time constant from initial switch on, thevoltage across the capacitor will be:

   (a) 100% of the supply voltage

   (b) 63.2% of the supply voltage

   (c) 50% of the supply voltage

(d) 36.8% of the supply voltage

9. Increasing the resistance in an R-C circuit would cause the time constant to:
   (a) reach a maximum value on charging
   (b) remain the same
   (c) increase
   (d) decrease

10. The practical unit of capacitance is the:
   (a) micro-coulomb
   (b) milli-farad
   (c) micro-farad
   (d) farad.

Section B:

Blank spaces in the following statements represent omissions. Write the appropriateinformation.

11. Capacitors are classified by their______________material.

12. The unit of capacitance is the______________.

13. A capacitor is said to be fully charged when the charging current becomes_________.

14. One microfarad is equal to______________farads.

15. The three factors that effect the capacitance of a capacitor are the type of ___________, the______________of the plates and the______________the plates.

16. The time constant of an R-C circuit is a measure of the time taken to ______________ or_____a capac

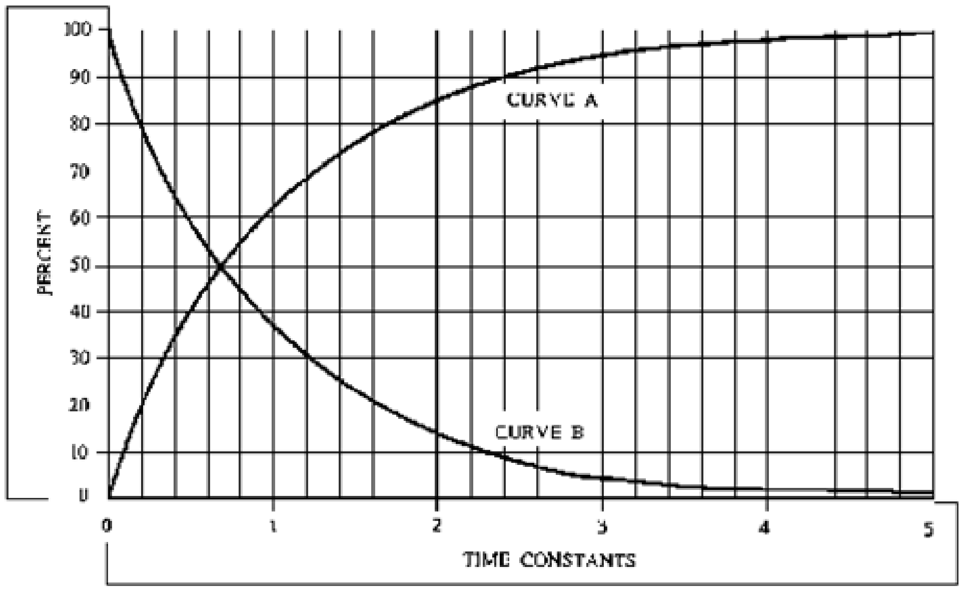
17. ______________ type capacitors have large values of capacitance for a small physicalsize.

18. In an R-C circuit, the time taken to fully charge the capacitor is approximately ____ time constants.

19. In a circuit containing resistance and capacitance in series the time taken for the capacitor voltage to reach 63.2% of its maximum value is known as the _________ of the circuit.

20. The arc created by contacts opening an energised circuit may be suppressed byconnecting a__across the contacts.

21. The charge stored by a capacitor depends on the capacitance of the capacitor and the _____________ to which the capacitor is charged.



SECTION C

The following problems are to be solved with the aid of a calculator. All equations andworking are to be shown.

22. Determine the charge on a 47µF capacitor when connected to a 12V supply.(564µC)

23. A 100µF capacitor is to store a charge of 0.005 coulombs. Determined the voltage thathas to be applied to the capacitor. (50V)

24. Determine the capacitance of a capacitor that is required to store a charge of 250µCwhen connected to a 20V supply. (12.5µF)

25. If a capacitor stores a charge of 15mC when connected to a 10V supply, what chargewill be stored when connected to a 32V supply? (48mC)

26. An R-C circuit consists of a resistance of 120kΩ and a capacitance of 36µF.Determine the -

    (a) time constant of the circuit (4.32 seconds)

    (b) time taken for the capacitor to fully charge. (21.6 seconds)

27. An R-C circuit has an applied voltage of 24V. What is the voltage across the

capacitorafter one time constant. (15.17V)

28. If the time taken to fully charge a 470μF capacitor is 28.2 seconds, determine the -
    - (a) time duration for one time constant (5.64 seconds)
    - (b) value of the series resistor. (12kΩ)

29. The time constant for an R-C circuit is 33 seconds. If the series resistor has a value of1MΩ, what is the value of the capacitor? (33μF)

30. A 500μF capacitor is connected in series with a 4kΩ resistor, and the circuit isconnected to a 20V dc supply. For this circuit determine the -
    - (a) time constant (2 seconds)
    - (b) circuit current at the instant the capacitor starts to charge (when Vc = 0V)(5mA)
    - (c) circuit current when the capacitor is fully charged (0A)
    - (d) capacitor voltage after 3.2 seconds using the universal time constant curve(15.6V)
    - (e) time required for the capacitor voltage to reach 10V - use curve (1.32seconds).
    - (f) resistor voltage after 3 time constants - use curve (0.8V)
    - (g) circuit current after 2.5 seconds - use curve (1.5mA)
    - (h) time taken for the circuit current to drop to 2mA - use curve (1.8seconds)

TUTORIAL - CAPACITORS IN SERIES AND PARALLEL

NAME: ____

Please note the following requirements in relation to tutorial work -

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- All relevant equations and working are to be shown in the case of calculation typequestions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifyingletter on your answer sheet.

1. If three equal capacitors are connected in series and charged, the charge on eachcapacitor will be:

    (a) one third of the total charge.

    (b) equal to the total charge.

    (c) three times the total charge.

    (d) independent of the total charge.

2. Two, 2μF capacitors connected in parallel will have a total capacitance of:

    (a) 4μF

    (b) 2μF

    (c) 1μF

    (d) 0.5μF

3. Two, 4μF capacitors connected in series will have a total capacitance of:

(a) 8μF
(b) 4μF
(c) 2μF
(d) 0.25μF.

4. A capacitor is a device used for:

(a) storing an electric charge.
(b) generating an electric charge.
(c) converting a.c. to d.c.
(d) creating reactance in a d.c. circuit

5. Increasing the capacitance in an R-C circuit will cause the time constant to:

(a) reach a maximum value on charging.
(b) remain the same.
(c) increase.
(d) decrease.

6. In an R-C circuit, after a period of one time constant from initial switch on, thevoltage across the capacitor will be:

(a) 36.8% of the supply voltage.
(b) 100% of the supply voltage.
(c) 63.2% of the supply voltage.
(d) 50% of the supply voltage.

7. Increasing the resistance in an R-C circuit would cause the time constant to:

   (a) decrease.
   (b) reach a maximum value on charging.
   (c) remain the same.
   (d) increase

14: Capacitor in Series and Parallel

8. The practical unit of capacitance is the:

   (a) farad.
   (b) micro-coulomb.
   (c) milli-farad.
   (d) micro-farad

Section B:

Blank spaces in the following statements represent omissions. Write the appropriateinformation.

9. To increase the capacitance of a capacitor, you would____________the plate area, or ____________ the distance between the plates.

10. When capacitors are connected in parallel, the equivalent capacitance of the circuitwill____.

11. Capacitance is measured using a unit called the_____(4)_____, but a more practical unitis the_.

12. When capacitors are connected in series, the equivalent capacitance of the circuit will ____________ .

13. To increase the capacitance of a circuit, capacitors are connected in____________, andto reduce the ci

14. Long cable runs with cables such as two core insulated and sheathed have capacitance.This is because the cable consists of__separated by an_____________.

15. In an R-C circuit, the time taken to fully charge the capacitor is approximately ____(11)____time constants.

16. In a circuit containing resistance and capacitance in series the time taken for the capacitor voltage to reach 63.2% of its maximum value is known as the _________ of the circuit.

17. The arc created by contacts opening an energised circuit may be

suppressed byconnecting a across the contacts.

18. The charge stored by a capacitor depends on the capacitance of the capacitor and the ___________ to which the capacitor is charged.

The following problems are to be solved with the aid of a calculator. All equations andworking are to be shown.

19. Determine the charge on a 47µF capacitor when connected to a 12V supply.(564µC)

20. A capacitor has a capacitance of 20µF and when connected to the supply stores acharge of 0.004C. Calculate the –

    (a) applied voltage (200V)

    (b) average charging time, if the charging current was 20mA. (0.2S)

21. What would be the equivalent capacitance of four capacitors with capacitances of 2,4, 6 and 12µF that are connected in –

    (a) series (1µF)

    (b) parallel (24µF)

22. Two capacitors having a capacitance of 8 an 12µF respectively are connected inparallel across a 250V supply. Determine the –

    (a) equivalent capacitance of the group (20µF)

    (b) charge stored on each capacitor (0.002C, 0.003C)

    (c) voltage across each capacitor. (250V)

23. Three capacitors having capacitances of 20, 40 and 100µF, are connected in parallelacross a 400V supply. Determine the –

    (a) equivalent capacitance (160µF)

    (b) total charge stored (0.064C)

    (c) charge stored on each capacitor. (0.008C, 0.016C, 0.04C)

24. How many 5µF capacitors would be required to give a capacitance of

65μF whenconnected in parallel? Also determine the total charge taken when the group is supplied from a 130V supply. (13, 0.00845C)

---

25. Three capacitors A. B and C, having capacitances of 6, 9 and 18μF, are connected inseries across a 200V d.c. supply. Calculate the –

    (a) equivalent capacitance (3μF)
    (b) total charge stored (0.0006C)
    (c) charge stored on each capacitor (0.0006C)
    (d) voltage drop across each capacitor. (100V, 66.7V, 33.3V)

26. Three capacitors having capacitances of 4, 6 and 12μF are connected in series across a120V supply. Calculate the –

    (a) equivalent capacitance (2μF)
    (b) total charge stored (0.00024C)
    (c) charge stored on each capacitor (0.00024C)

27. Three capacitors are connected in series have an equivalent capacitance of 10μF. If two of them have capacitances of 30 and 60μF, determine the capacitance of the thirdcapacitor. (20μF)

28. Determine the number of 4μF capacitors which must be connected in series to producean equivalent capacitance of 0.25μF. (16)

29. Four capacitors, each having a capacitance of 10μF, are available. Draw neat diagramsshowing how they would be grouped to give –

    (a) maximum capacitance.
    (b) minimum capacitance.

    Also calculate the maximum and minimum values of capacitance. (40μF,2.5μF)

****

A.C. Principles

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- In the case of multiple choice type questions, the question number and corresponding answer letter are to be written on the answer sheet.
- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The value of AC voltage shown on the name plate of an appliance is the:
   (a) average value
   (b) peak value
   (c) instantaneous value
   (d) r.m.s. value

2. The value of AC voltage that has the same heating effect as the equivalent value of DCvoltage is the:
   (a) rms value.
   (b) peak value.
   (c) average value.
   (d) peak to peak value.

3. For one complete cycle of an AC supply, the current flow:
   (a) will remain constant in magnitude.
   (b) will flow in one direction only.
   (c) will flow in one direction then reverses direction.
   (d) reaches a maximum in one direction then falls to zero.

4. The standard unit of frequency is the:
   (a) Hertz (Hz)
   (b) Volt (V)
   (c) period (T)
   (d) cycle per second (CPS)

5. The term *frequency* of an AC supply is defined as the:
   (a) number of cycles completed in one minute.
   (b) number of cycles completed in one second.
   (c) time required to complete one cycle.
   (d) the amount of a cycle completed in one second.

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. The standard________(a)__of the AC supply in Australia is 50Hz, and this means that there are50_(b)_.

7. ______ will continuously change its direction of current flow with time.

8. With reference to a sinusoidal waveform, define what is meant by the following terms:
   (a) period;
   (b) form factor;
   (c) peak value;
   (d) average value;
   (e) peak to peak value; and
   (f) instantaneous value.

9. The ratio of the peak value of voltage to the rms value of voltage is known as the_(a)___, and for a sinusoidal waveform has a value of__(b)___.

10. The ratio of the rms value of voltage to the average value of voltage is known as the ___(a)___, and for a sinusoidal waveform has a value of____(b)___.

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

11. A sinusoidal wave has a maximum value of 340 volts. Determine the instantaneous value ofvoltage at angles of:
   (a) 45^0 (240V)
   (b) 105^0 (328.4V)
   (c) 260^0 (334.8V)
   (d) 330^0 (-170V)

12. A sinusoidal wave has a frequency of 400 Hz.. Determine the period for this frequency.(2.5mS)

13. A sinusoidal wave has a maximum value of 500 volts. For this wave, determine:
    (a) the rms value; (353.6V)
    (b) the peak to peak value; (1000V)
    (c) the average value. (318.5V)

14. Determine the frequencies for the following periodic times:
    (a) 0.02 seconds (50Hz)
    (b) 0.0833 seconds (12Hz)
    (c) 1 millisecond (1000Hz)
    (d) 0.05 milliseconds (20kHz)

The following questions refers to Table 1 and the graph shown on page 4. Add page 4 to your submitted tutorial solution.

15. Complete the sin value row of Table 1 by determining the sine values for the angles asshown.

16. If the maximum voltage of the waveform is 120V, complete the voltage value row of Table 1 by determining the instantaneous values of voltage for the angles shown using your calculated sin values.

17. Carefully plot the results on the graph supplied, completing your waveform using either French curves or a flexicurve. **Do not finish your waveform in freehand!**

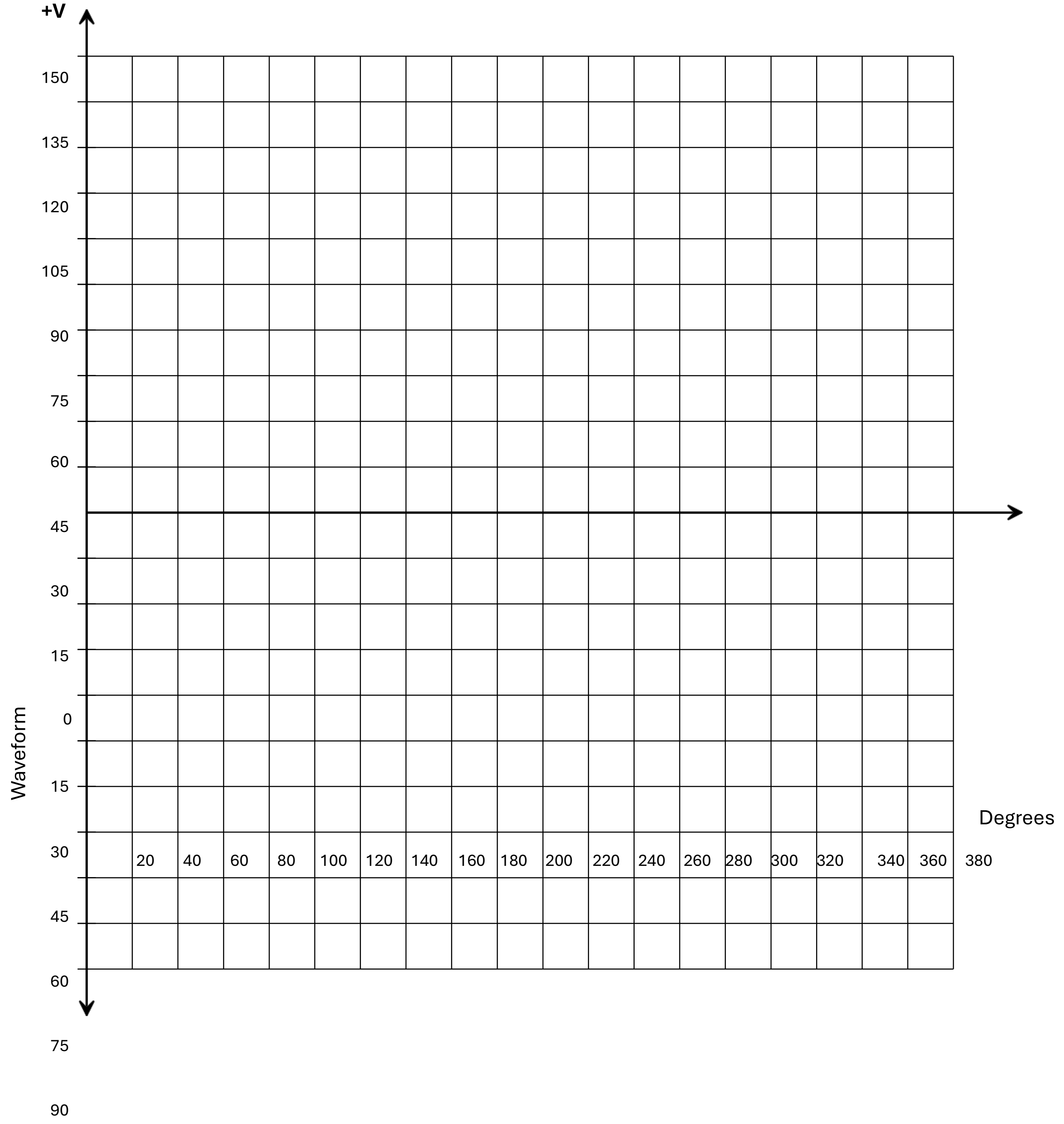
18. On your completed waveform, label the following:
    (a) the peak value,
    (b) the peak to peak value,
    (c) the periodic time,

19. Draw and label straight lines where you would expect to find the:
    (a) the rms value,
    (b) the average value.

20. From your waveform, determine the value of voltage
    at:(a) 20^0 (41V)
    (b) 100^0 (118V)
    (c) 220^0 (-077V)
    (d) 140^0 (77V)

Degrees	0	15	30	45	60	75	90	105	120	135	150	165	180
Sin Value													
Voltage Value													
Degrees	195	210	225	240	255	270	285	300	315	330	345	360	
Sin Value													
Voltage Value													

Table 1



105

120

135

150

- V

Sinusoidal Waveforms

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- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. When measuring the phase difference with a CRO., the CRO.
   (a) must be able to show two waveforms.
   (b) needs to have a high sensitivity.
   (c) time base must be re-calibrated.
   (d) must be set to DC input.

2. Phasors are quantities which vary in:
   (a) magnitude and time only
   (b) magnitude and direction only
   (c) magnitude, direction and time
   (d) direction only

3. If one waveform leads another, then it will pass through_____and maximum values ______ the other waveform.
   (a) zero; before
   (b) zero; after
   (c) zero; simaltaneously with

4. In practice, when representing AC quantities by phasor diagram, the phasors are usually drawnto scale to represent:
   (a) rms values
   (b) instantaneous values
   (c) maximum values
   (d) average values

5. The term *phase angle* is defined as the:

(a) angle used to determine the instantaneous value of voltage or current.
(b) the angular displacement between two waveforms of the same frequency.
(c) the angular displacement between two waveforms of different frequencies.
(d) the number of degrees into a cycle where the peak value is reached.

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. Two waveshapes are said to be_____when they pass through their zero points or peak valuessimultaneously.

7. To represent a voltage quantity in a phasor diagram, an arrow with a/an__(a)__ head is used, whilst a current quantity is represented by an arrow with a/an____(b)___ head. Draw an example of a voltage phasor representing 100V (1.0mm = 2.5V), and an example of a current phasor representing 24A (1.0mm = 0.3A).

8. If two waveshapes do not pass through the same changes at the same time, they are said to be ______

9. To determine the frequency of a sinewave from a CRO., you would read the_(a)___axis and use the the setting of the__(b)___switch.

10. Briefly describe how you could determine:
    (a) if two waveshapes are in phase;
    (b) if two waveshapes are out of phase;
    (c) if out of phase, which one leads or lags the other.

11. Phasors are normally drawn to scale to represent____quantities.

12. The relationship between frequency and periodic time states that frequency is_____(a) toperiodic time. This can be written mathematically as_____(b)_________________

13. Phasors are said to rotate in a/an_____direction.

14. Briefly describe how you could prove that the rms value of a sinewave is 0.707 of the peak peakvalue of a sinewave. Accompany your answer with a clearly labelled diagram.

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

15. A display of a sinusoidal waveform on a CRO. is 2.8 divisions high and 8 divisions long. If the VOLTS/DIV is set to 10V, and the SWEEP TIME/DIV is set to 1mS, determine:
    (a) the peak value of voltage (28V)
    (b) the expected rms value of voltage (19.8V)
    (c) the frequency of the waveform (125Hz)

16. Two sinusoidal waves with a frequency of 50 Hz are displayed on a CRO. If the horizontal displacement between the waveforms is measured to be 3.5mS, determine the phase anglebetween the two waveshapes (63^0)

17. Draw a phasor diagram to represent a voltage V1 of 240V and a second voltage V2 of 180V, such that V1 leads V2 by 50^0. Use a scale of 1.0mm = 2.0V, and make V1 the reference.

18. Draw a phasor to represent a current I1 of 2.5A, a second current I2 of 3A and a third current I3 of 1.75A, drawn to scale of 1.0mm = 25mA. I1 leads I2 by 30^0, and I3 lags I2 by 45^0. Use I2 as your reference phasor.

19. The diagram of figure 1 represents two sinusoidal waveforms of the same frequency. If the VOLTS/DIV switch is set to 10V, and the SWEEP TIME/DIV switch is set to 5mS, determine:
    (a) the peak values of voltage for waveforms V1 and V2; (V1pk=30V; V2pk=36V)
    (b) the peak to peak values of voltage for waveforms V1 and V2; (V1pk-pk=60V; V2pk-pk=72V)
    (c) the expected rms values of the two waveforms; (V1=21.2V;V2=25.5V)
    (d) the frequency of the waveforms; (20Hz)
    (e) the phase angle between the two waveforms; (57.6^0)
    (f) if V1 leads or lags V2.
    (g) draw a phasor diagram to represent the two voltages, using a scale of 1.0mm = 0.2V.

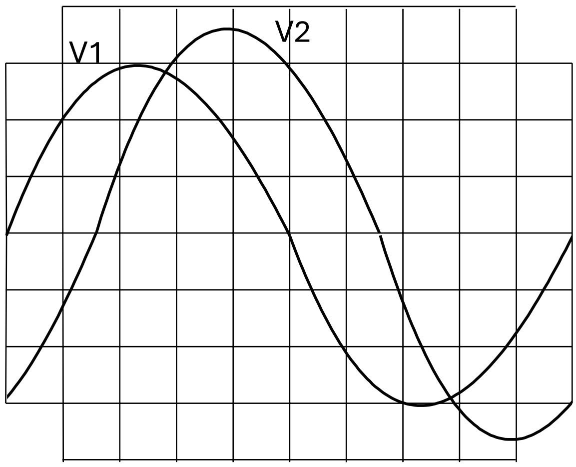

Figure 1

Phasor Quantities

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- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. Current phasors are represented by an arrow with a/an____head, whilst voltage phasors arerepresented by an arrow with a/an__head.
   (a) closed, open
   (b) open, open
   (c) open, closed
   (d) closed, closed

2. The resultant of two or more voltages differing in phase angle may be determined by:
   (a) algebraic addition
   (b) averaging the voltage values
   (c) phasor addition
   (d) numerical addition

3. To find the phasor difference of two phasor quantities, the method to use is:
   (a) tip to tail.
   (b) tip to tip.
   (c) tail to tail.
   (d) non existent.

4. If a phasor is used to show a______quantity, it will be drawn above the_______reference line.
   (a) lagging, horizontal
   (b) leading, horizontal
   (c) leading, vertical
   (d) lagging, vertical

5. The resultant of two voltages, having the same phase angle but different numerical values can bedetermined by:
   numerical addition

numerical subtraction
phasor subtraction
algebraic addition

NOTES

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. When adding phasor quantities, the method used is described as __(a)__ to ___(b)___, but when subtracting phasor quantities, the method used is described as_(c) to_(d)_.

7. Phasor addition or subtraction is used to add or subtract quantities which are differing in__.

8. When solving for series circuits using phasor diagrams, the reference to use is circuit_(a)__, whilst for parallel circuits, the reference to use is circuit__(b)__. These references are used because they are (c) to all parts of their respective circuits.

9. Briefly explain why it is important for phasors to be drawn accurately and to scale.

10. If a phasor quantity leads the reference phasor, it is drawn ___(a)___ the reference, and if a phasor quantity lags the reference phasor, it is drawn (b) the reference.

11. List three advantages of using phasor diagrams for phasor addition or subtraction over using waveform diagrams for waveform addition or subtraction.

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple. Any question solved by phasor diagram should be drawn accurately to scale on 5mm graph paper attached to your solution.

12. Using a scale of 1mm = 1.0 volts, determine the resultant of the voltages Va and Vb in the diagram of figure 1 by phasor diagram. Clearly label all voltages and angles on your diagram. [120V @ 17^0 lag]

13. A heating element is connected in parallel to a 240 volt, 50Hz single phase motor. The current drawn by the heating element is 10A, and is in phase with the supply voltage, whilst the current drawn by the motor is 7A, and lags the supply voltage by 70^0 . Using a scale of 1mm = 0.1A, determine the current drawn from the supply, and the resultant circuit phase angle. [14A @ 28^0 lag]

14. A capacitor is connected in series with a resistor. The voltage across the capacitor is 190 volts leading by 90^0, and the voltage across the resistor is 147 volts, and is in phase with the circuit

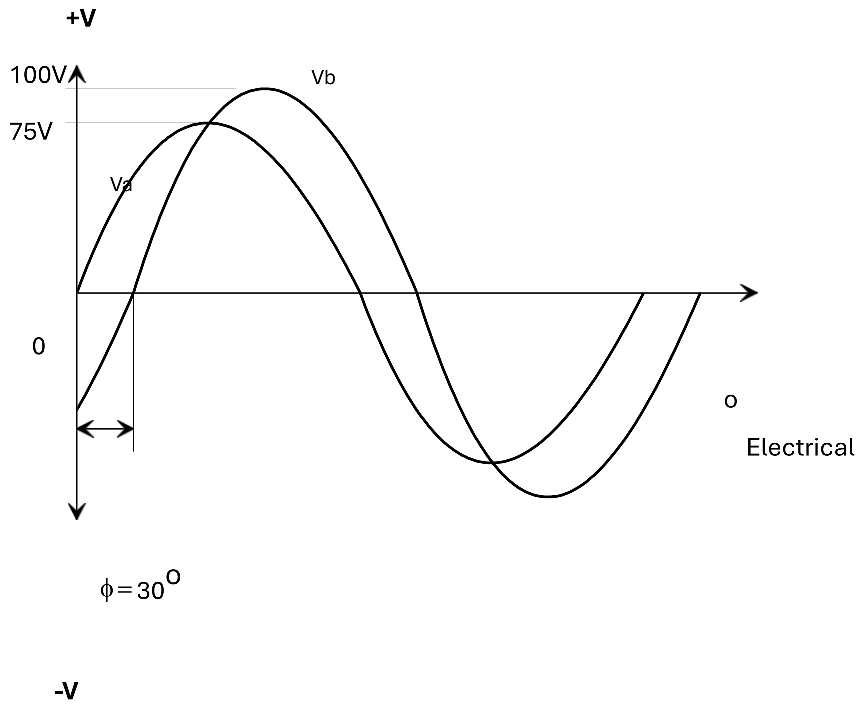

Figure 1

current. Using a scale of 1mm = 2.0V, determine the value of voltage connected across the supply, and the resultant circuit phase angle. [240V @ 52^0 lead]

15. A 240 volt, 50Hz single phase motor draws 18A from the supply at a lagging phase angle of 40^0. A capacitor connected across the motor draws 7A at a leading phase angle of 90^0. Using a scale of 1mm = 0.2A, determine the current drawn from the supply, and the resultant circuit phase angle. [14.5A @ 18.5^0 lag]

16. For the circuit of figure 2, determine the value and phase angle for the branch current I2. Use a scale of 1mm = 0.05A. [4.5A @ 90^0 lead].

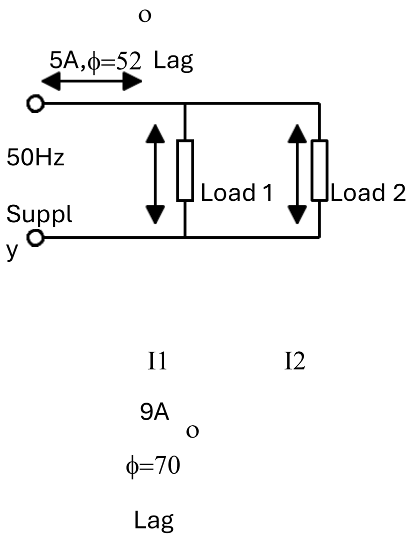

Figure 2

NOTES

Resistance & Capacitance in AC Circuits

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- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The phase angle (ϕ) between voltage and current in a purely resistive circuit is:
   (a) 180 electrical degrees.
   (b) 90 electrical degrees.
   (c) 45 electrical degrees.
   (d) 0 electrical degrees.

2. The opposition to current flow in a purely capacitive circuit is known as____and is measuredin ____
   (a) capacitive reactance, ohms
   (b) resistance, ohms
   (c) capacitive reactance, farads
   (d) impedance, farads

3. The phase angle (ϕ) between voltage and current in a purely capacitive circuit is:
   (a) 180 electrical degrees.
   (b) 90 electrical degrees.
   (c) 45 electrical degrees.
   (d) 0 electrical degrees.

4. Adding extra resistance to a purely resistive circuit will cause the phase angle (ϕ) betweenvoltage and current to:
   (a) increase.
   (b) decrease.
   (c) remain unchanged.
   (d) become maximum.

NOTES

5. The capacitive reactance of a capacitor is inversely proportional to the ___ and ______ value.
   (a) supply frequency, capacitance
   (b) supply current, capacitance
   (c) supply frequency, supply voltage
   (d) supply voltage, capacitance

6. Adding extra capacitance to a purely capacitive circuit will cause the phase angle (ϕ) betweenvoltage and current to:
   (a) increase.
   (b) decrease.
   (c) remain unchanged.
   (d) become maximum.

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

7. The power dissipation in an AC circuit is known as the__(a)___power, and for a capacitivecircuit is equal to____________________________(b)___.

8. In a purely resistive circuit, the circuit current and the circuit voltage are____.

9. If extra resistance is added to a purely resistive circuit, the equivalent circuit resistance can befound by_.

10. In a purely capacitive circuit, the circuit current and the circuit voltage are_(b)____, and thecurrent(b)____the voltage by____(c)____.

11. The capacitive___(a)___of a capacitor is measured in ohms because it_(b)____current flow.

12. A capacitor "looks" like an___(a)___circuit to a DC supply once it is charged, but "looks" like a_____(b)___ circuit to an AC supply due to the charge and discharge_____(c)___ that are continuously flowing.

13. A purely resistive AC circuit can be treated in the same manner as a_(a)___circuit. This is because the phase angle (ϕ) in a resistive circuit is_(b)____.

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple. Any question solved by phasor diagram should be drawn accurately to scale on 5mm graph paper attached to your solution.

14. A circuit of 20Ω resistance draws 16A when connected to an AC supply. Determine:
    (a) the voltage applied to the circuit, (320V)
    (b) the power consumed by the circuit, (5.12kW)

15. A heating element is connected to a 240 volt, 50Hz supply. If the rating of the heater is 1.5kW,determine the current flowing in the circuit. (6.25A)

16. Determine the capacitive reactance of a 47μF capacitor when connected to a 32V, 50Hz supply.(67.7Ω)]

17. Determine the current taken by a 390μF capacitor when connected to a 240V, 50Hz supply.(29.4A)

18. A capacitor takes 3A when connected to a 240V, 50Hz supply. Determine:
    (a) the capacitive reactance of the capacitor; (80Ω)
    (b) the capacitance of the capacitor. (39.8μF)

19. A capacitor takes 6A when connected to a 240V, 50Hz supply. Determine how much current thecapacitor will take if it is reconnected to a 115V, 400Hz supply. (23A)

20. For the circuit of figure 1, determine:
    (a) the resistances of R1 and R2; (4.8Ω; 3.43Ω)
    (b) the current taken from the supply; (12A)
    (c) the equivalent resistance of the circuit; (2Ω)
    (d) the power dissipated by each resistive (120W; 168W)
    (e) the total power dissipated by the circuit, (288W)
    (f) draw the phasor diagram for the circuit .

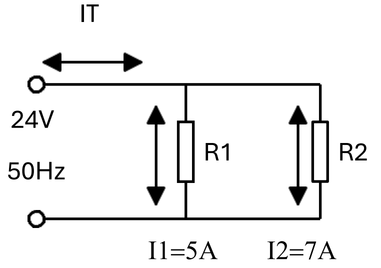

Figure 1

21. For the circuit of figure 2, determine:
    (a) the capacitive reactances of C1 and C2; (56.8Ω; 81.6Ω)
    (b) the capacitances of C1 and C2; (56μF; 39μF)
    (c) the current taken from the supply; (7.16A)
    (d) the equivalent capacitive reactance of the circuit; (33.5Ω)
    (e) the equivalent capacitance of the circuit (95μF);
    (f) the total power dissipated by the circuit, (0W)
    (g) draw the phasor diagram for the circuit .

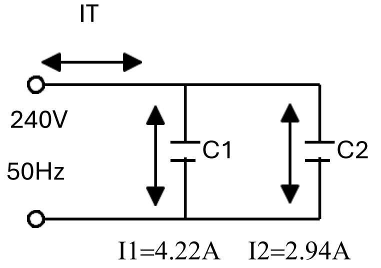

Figure 2

NOTES

Inductance in AC Circuits

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SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The phase angle (ϕ) between voltage and current in a purely inductive circuit is:
   (a) 0 electrical degrees.
   (b) 45 electrical degrees.
   (c) 90 electrical degrees.
   (d) 180 electrical degrees.

2. The opposition to current flow in a purely inductive circuit is known as_____and is measuredin ____
   (a) resistance, ohms
   (b) inductive reactance, ohms
   (c) inductive reactance, henries
   (d) impedance, henries

3. Adding extra inductance to a purely inductive circuit will cause the phase angle (ϕ) betweenvoltage and current to:
   (a) increase.
   (b) decrease.
   (c) remain unchanged.
   (d) become maximum.

4. Inductors (such as ballasts) are used to control current in AC circuits as they:
   (a) have a low power loss.
   (b) have a good power factor.
   (c) are cheaper than resistors.
   (d) have a low value of reactance.

5. The inductive reactance of a inductor is _____ to the supply frequency and _______ to the circuit inductance value.
   (a) proportional, inversely proportional
   (b) proportional, proportional
   (c) inversely proportional, inversely proportional
   (d) inversely proportional, proportional

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. The power dissipation for an inductive circuit is equal to___(a)____. This is because the energyis returned to the supply when the (b) collapses.

7. Inductive reactance is an example of_____Law "in action".

8. In a purely inductive circuit, the circuit current and the circuit voltage are__(b)___, and the current___(b)___ the voltage by___(c)___. This is due to the____(d)___ that is continuously generated in the inductor.

9. The inductive ___(a)___ of an inductor is measured in ___(b)___ because it opposes current flow.

10. An "ideal" inductor has___(a)___resistance, whilst a practical inductor has_(b)___.

11. As the frequency of a supply connected to an ideal coil increases, the ___(a)____(b)___ of the coil increases.

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple. Any question solved by phasor diagram should be drawn accurately to scale on 5mm graph paper attached to your solution.

12. When connected to a 24V, 50Hz supply, an ideal inductor draws 1.2A. Determine the reactance of the inductor. (20Ω)

13. If a coil of negligible resistance has an inductance of 0.05 henry, determine its inductive reactance if connected to a:
   (a) 50Hz supply, (15.7Ω)
   (b) 33Hz supply, and (10.4Ω)
   (c) 1kHz supply. (314Ω)

14. A coil of negligible resistance draws 0.5A when connected to a 240V, 50Hz supply. Determinethe inductance of the coil. (1.53H)

15. An ideal 153mH inductor is rated to be used on a 240V, 50Hz supply, but instead is connected toa 200V, 400Hz supply. Determine the current flowing in the inductor for both of these conditions. (@50Hz: 5A; @400Hz: 0.52A)

16. A coil of negligible resistance draws 1A when connected to a 32V, 120Hz supply.
   (a) Determine how much current it will draw from a 415V, 50hz supply. (31.1A)
   (b) Draw a phasor diagram for each of the operating conditions. Pick a suitable scale for eachdiagram, noting the scales you have used next to your phasor diagrams.

R.L & R.C Series AC Circuits

Please note the following requirements in relation to tutorial work -

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- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The phase angle (ϕ) between voltage and current in an R.L. series circuit is between:
   (a) 0^0 and 90^0 lagging.
   (b) 0^0 and 90^0 leading.
   (c) 90^0 and 180^0 lagging.
   (d) 90^0 and 180^0 leading.

2. Adding extra inductance to an R.L. series circuit will cause the phase angle (ϕ) between voltageand current to:
   (a) remain unchanged.
   (b) increase.
   (c) become maximum.
   (d) decrease.

3. The opposition to current flow in any ac circuit containing_____and reactive components isknown as_____and is measured in ohms.
   (a) capacitive , reactance
   (b) inductive reactance
   (c) resistive, impedance
   (d) inductive, impedance

4. Adding extra resistance to an R.C. series circuit will cause the phase angle (ϕ) between voltageand current to:
   (a) remain unchanged.
   (b) increase.
   (c) become maximum.
   (d) decrease.

NOTES

5. If the inductive reactance and resistance of an R.L. series circuit are equal, the circuit phaseangle will be:
   (a) 45^0 lead
   (b) 45^0 lag
   (c) 30^0 lead
   (d) 60^0 lag

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. To decrease the phase angle in an R.L. series circuit, either_(a)___the circuit resistance, or ___(b)___the circuit inductance.

7. In an impedance triangle for an R.L. series circuit, the circuit resistance is_(a)___with the reference, the circuit__(b)___will____(c)___the reference, whilst the circuit impedance is the
   ___(d)___. Accompany your answer with a diagram to show the relationships for a series R.L. circuit.

8. The circuit phase angle for an R.C. circuit is between_(a)___and____(b)___, and the currentwill__(c)______________________________the voltage.

9. To increase the phase angle in an R.C. series circuit, either_(a)___the circuit resistance, or ___(b)___the circuit____(c)___.

10. Increasing the supply frequency to an R.L. series circuit will cause the circuit phase angle to ______.

11. Decreasing the supply frequency to an R.C. series circuit will cause the circuit phase angle to
    ______.

12. When using an impedance triangle to solve for series R.L or R.C circuits, the phase angle ismeasured between the circuit______________(a)___and the circuit (b)____

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple. Any question solved by phasor diagram should be drawn accurately to scale on 5mm graph paper attached to your solution.

13. Determine the impedance of a series R.L circuit consisting of a 220Ω resistor and a 1.59H idealinductor when connected to a 240V, 50Hz supply. (546Ω)

14. If a 120Ω resistor is connected in series with 0.75H ideal inductor, determine how much currentwill flow if connected to a 415V, 50Hz supply. (1.57A)

NOTES

15. Determine the impedance if the 220Ω resistor of Q12 is now connected in series with a 22μF capacitor when connected to a 240V, 50Hz supply. (263Ω)

16. A 560Ω resistor is connected in series with a 5.68μF capacitor. Determine the current flowing in this circuit if connected to a 240V, 50Hz supply. (303mA)

17. An R.L. series circuit draws 0.333A when connected to a 32V, 50Hz supply. Determine the value of the circuits resistance and inductance if the circuit phase angle is measured to be 60^0lag. (R=48Ω; L=265mH)

18. When connected to a 200V, 400Hz supply, an R.C. series circuit draws 2A. If the circuit phase angle is found to to 45^0, determine the value of the circuits resistance and capacitance. (R=70.7Ω; C=5.6μF)

19. When connected to a 50Hz supply, an R.L. series circuit draws 0.4A. If the voltage drop acrossthe resistor is 16V, and the voltage drop across the ideal inductor is 12V, determine:
    (a) the voltage applied to the circuit by phasor diagram using a scale of 1mm = 0.2V; (20V)
    (b) the circuit phase angle. (37^0 lag)
    (c) the resistance of the resistor; (40Ω)
    (d) the reactance of the inductor; (30Ω)
    (e) the circuit impedance; (50Ω)
    (f) the inductance of the inductor; (95.5mH)
    (g) the minimum power rating for the resistor. (6.4W)

20. When connected to a 50Hz supply, an 80Ω resistor connected in series with a 33μF capacitor draws a current of 2A . Determine by phasor diagram the voltage applied to the circuit and the circuit phase angle using a scale of 1mm = 2V. (250V; $\phi = 50^0$ lead)

Series R.L.C Circuits

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- In the case of multiple choice type questions, the question number and corresponding answer letter are to be written on the answer sheet.
- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. If the circuit phase angle in an R.L.C. series circuit is between 0^0 and 90^0 lagging, then the _____ is higher than the ______.
    (a) capacitive reactance, inductive reactance

NOTES

4. Series resonance occurs when:
   (a) $X_L = Z$
   (b) $X_C = Z$
   (c) $X_L = X_C$
   (d) $X_L + X_C = R$

5. As the voltage drops in a series R.L.C. circuit are ______, they are added by ______ .
   (a) out of phase, phasor addition
   (b) in phase, phasor addition
   (c) out of phase, numerical addition
   (d) in phase, numerical addition

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. To decrease the phase angle in a series R.L.C. circuit, either ___(a)___ the circuit effective reactance, or ___(b)___ the circuit resistance.

7. At series resonance, the circuit impedance is a ___(a)___ value, and the circuit current is a ___(b)___ value.

8. If resonance occurs in a power series R.L.C. circuit, the ___(a)___ across the reactive components can become ___(b)___ .

9. Increasing the supply frequency to a series R.L.C. circuit with a leading phase angle will cause the inductive reactance to ___(a)___, the capacitive reactance to ___(b)___, and the circuit phase angle to ___(c)___.

10. Decreasing the supply frequency to a lagging R.L.C. series circuit will cause the circuit phase angle to ______.

11. When a series circuit is operating at resonant frequency, ___(a)___ reactance equals ___(b)___, and impedance equals ___(b)___, and the circuit current is ___(c)___

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple. Any question solved by phasor diagram should be drawn accurately to scale on 5mm graph paper attached to your solution.

12. A 27Ω resistor is connected in series with a 250mH inductor and a 33μF capacitor. If connected to a 50Hz supply, determine the impedance of the circuit. (32.4Ω)

13. Determine the supply current if a 50Ω resistor is connected in series with an inductor with a reactance of 60Ω and a capacitor with a reactance of 80Ω when connected to a 240V, 50Hz supply. (4.46A)

14. A 200mH inductor is connected in series with a 100μF capacitor and an unknown resistor. Determine the value of the unknown resistor if the circuit draws 5A when connected to a 240V, 50Hz supply. (36.6Ω)

15. For the circuit of figure 1, determine the:
    (a) reactance of the inductor (235.6Ω)
    (b) reactance of the capacitor (159Ω)
    (c) impedance of the circuit (280.6Ω)
    (d) current flowing in the circuit (1.48A)
    (e) voltage drop across the inductor (348V)
    (f) voltage drop across the capacitor (235V)
    (g) voltage drop across the resistor (399V)
    (h) circuit phase angle (15.8^0 lag)

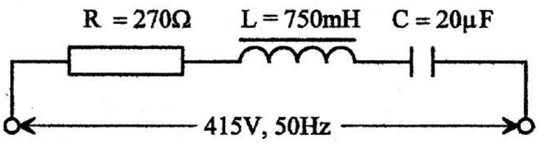

Figure 1

16. If the circuit of figure is connected to a variable frequency power supply, determine the resonant frequency of the circuit. (41Hz)

17. When connected to a 50Hz supply, an 560Ω resistor connected in series with a 2.71H ideal inductor and a 5μF capacitor draws a current of 400mA . Determine by phasor diagram the voltage applied to the circuit and the circuit phase angle using a scale of 1mm = 2V. (240V;21^{0}lag)

Parallel A.C. Circuits

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- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The phase angle (ϕ) between voltage and current in an R.C. parallel circuit is between:
   (a) 0^0 and 90^0 lagging.
   (b) 0^0 and 90^0 leading.
   (c) 90^0 and 180^0 lagging.
   (d) 90^0 and 180^0 leading.

2. Adding extra inductance to an R.L. parallel circuit will cause the phase angle (ϕ) betweenvoltage and current to:
   (a) remain unchanged.
   (b) increase.
   (c) become maximum.
   (d) decrease.

3. In a parallel resonant circuit, circuit impedance is a____, and circuit current is a______.
   (a) maximum, maximum
   (b) minimum, minimum
   (c) maximum, minimum
   (d) minimum, maximum

4. Adding extra capacitance to a leading R.L.C. parallel circuit will cause the phase angle (ϕ) between voltage and current to:
   (a) remain unchanged.
   (b) increase.
   (c) become maximum.
   (d) decrease.

5. In a parallel L.C. circuit, the component with the largest_____will determine the phase anglefor the circuit.
   (a) current
   (b) voltage
   (c) reactance
   (d) resistance

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

6. To decrease the phase angle in an R.L. parallel circuit, either_(a)___the circuit resistance, or ___(b)___the circuit inductance.

7. Increasing the frequency of the supply to an R.L.C. parallel circuit will cause the resistivecurrent to_(a)________________________, the inductive current to_____________(b) and the capacitive current to_________________(c)___

8. The circuit phase angle for an R.L. parallel circuit is between_(a)___and_____(b)___, and thecurrent will_(c)___the voltage.

9. To increase the phase angle in an R.C. parallel circuit, either_(a)___the circuit resistance, or ___(b)___the circuit_____(c)___.

10. Increasing the supply frequency to an R.L. parallel circuit will cause the circuit phase angle to _______.

11. Decreasing the supply frequency to an R.C. parallel circuit will cause the circuit phase angle to _______.

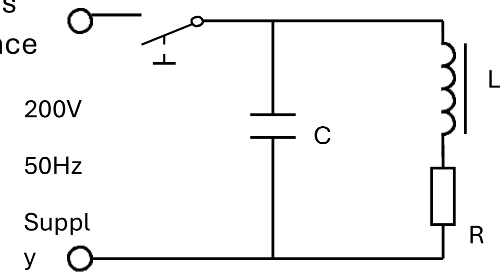
12. At parallel resonance, the circulating__(a)___ between the reactive components can be ___(b)___

NOTES

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple. Any question solved by phasor diagram should be drawn accurately to scale on 5mm graph paper attached to your solution.

13. For the circuit of figure 1, if the capacitive reactance is 25Ω, the inductive reactance is 30Ω and the resistance is 10Ω, determine
    (a) the impedance, current and phase angle for the capacitive branch; (25Ω, 8A, 90^0 lead)
    (b) the impedance, current and phase angle for the inductive branch; (31.6Ω, 6.33A, 71.5^0 lag)
    (c) the supply current and circuit phase angle; (2.83A,45^0 lead) (1mm = 0.1A
    (d) the circuit impedance. (70.6Ω)



Figure

NOTES

14. For the circuit of figure 1, if the capacitor is 25μF, the inductor is 250mH and the resistance is15Ω, determine:
    (a) the capacitive current and phase angle; (1.57A, 90^0 lead)
    (b) the inductive current and phase angle; (2.5A, 79^0 lag)
    (c) the supply current and circuit phase angle; (1A, 61.6^0 lag) (1mm = 25mA)
    (d) the circuit impedance (200Ω)

15. If a 120Ω resistor is connected in parallel with 382mH inductor with a resistance of 35Ω, determine how much current will flow if connected to a 415V, 50Hz supply. (5.4A)
    (1mm = 50mA)

16. An L.C. parallel circuit is connected to a single phase 240V, 50Hz supply. If the current through the capacitor 12A, and the current through the inductor is 16A at a phase angle of 60^0 lagging, determine the:
    (a) impedance of the inductor; (15Ω)
    (b) resistance of the inductor; (7.5Ω)
    (c) impedance of the capacitor; (20Ω)
    (d) current drawn from the supply; (8.2A) (1mm = 0.2A)
    (e) circuit phase angle. (13.1^0 lag)
    (f) circuit impedance; (29.3Ω)

17. An 80Ω resistor connected in parallel with a 33μF capacitor is connected to a 250V, 50Hz supply. Determine by phasor diagram the current drawn from the supply and the circuit phase angle using a scale of 1mm = 0.05A. (4A; $\phi = 40^0$ lead)

Power in AC Circuits

Please note the following requirements in relation to tutorial work -

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SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. True power is measured in______and is a measure of the______.
   (a) volt-amps; power supplied
   (b) volt-amps ; power consumed
   (c) watts; power consumed
   (d) watts; power supplied

2. In a purely resistive circuit there is no:
   (a) apparent power
   (b) true power
   (c) average power
   (d) reactive power

3. In a power triangle, apparent power is represented by the:
   (a) side adjacent the phase angle
   (b) hypotenuse
   (c) side opposite the phase angle
   (d) cosine of the phase angle

4. Power factor is a ratio of:
   (a) reactive power to apparent
   (b) true power to reactive power
   (c) apparent power to true power
   (d) true power to apparent power

5. The power consumed in a circuit is determined by:
   (a) apparent power times the power factor
   (b) apparent power divided by the power factor
   (c) reactive power times the power factor
   (d) true power plus the power factor

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

1. Neatly copy the diagram of figure 1 on your answer sheet. On thediagram of figure 1, label which sides represent the:
   (a) apparent power,
   (b) true power;
   (c) reactive power;
   (d) also show which angle represents the phase angle for the circuit.

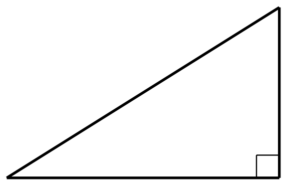

Figure 1

2. The power factor for a circuit can be found by either using the ratio of ___(a)___or by the____(b)___of the phase angle, and uses the symbol____(c)___.

3. True power is measured in__(a)___, and uses the circuit symbol__(b)___.

4. Apparent power is measured in__(a)___, and uses the circuit symbol__(b)___.

5. Reactive power is measured in__(c)___, and uses the circuit symbol__(b)___.

6. Reactive power is the power__(a)___to the supply when either the magnetic field of an ___(b)___collapses or a capacitor_____(c)___.

7. Power factor has a range of__(a)___ to____(b)___, and can be either____(c)___ for an inductive circuit or____(d)___for a capacitive circuit.

8. In a purely resistive circuit, the power factor is equal to_(a)___, or is said to be___(b)___ power factor.

9. If you wished to determine the power factor of a circuit, you would need a_(a)___to measure true power, a____(b)___ and an____(c)___ to measure apparent power, and you would use the ratio of____(d)___to calculate the power factor.

NOTES

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. A heating element connected to a 240V, 50Hz supply draws 10A. Determine the:
   (a) the circuit phase angle. (0°)
   (b) apparent power of the circuit; (2400VA)
   (c) true power consumed by the circuit. (2400W)

2. A capacitor connected to a 240V, 50Hz supply draws 12A. Determine the:
   (a) the circuit phase angle. (90° leading)
   (b) apparent power of the circuit; (2880VA)
   (c) true power consumed by the circuit. (0W)

3. A single phase 240V, 50Hz circuit draws 5A from the power supply, and operates at alagging power factor of 0.8. Determine the:
   (a) the circuit impedance; (48Ω)
   (b) the circuit phase angle. (36.8°)
   (c) true power consumed by the circuit; (960W)

4. A single phase load draws 2.5A from a 32V, 50Hz supply. If the power consumed by thecircuit is 60W, determine the:
   (a) the circuit impedance; (12.8Ω)
   (b) apparent power of the circuit; (80VA)
   (c) circuit power factor; (0.75)
   (d) circuit phase angle; (41.4°)
   (e) reactive power of the circuit; (52.9VAr)

5. A 240V, 50Hz, single phase circuit operates at a lagging phase angle of 30° . If the power consumed is 1.5kW, use a power triangle to determine the apparent and reactive power forthe circuit. Use a scale of 1mm = 15VA/W/VAr (S = 1.732kVA; Q = 863VAr)

Power Factor Improvement

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- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. Poor power factor is usually caused by:
   (a) inductive loads
   (b) resistive loads
   (c) low power consumption loads
   (d) high power consumption loads

2. In a purely resistive circuit the power factor is:
   (a) 0 - 1 leading
   (b) 0 - 1 lagging
   (c) unity
   (d) reactive power

3. Power factor correction is usually achieved by:
   (a) connecting a resistor in series with the load
   (b) connecting a capacitor in parallel with the load
   (c) connecting a special electronic correcting device to the load
   (d) any of the above methods.

4. When power factor correction is used, the:
   (a) circuit current decreases
   (b) true power decreases
   (c) reactive power power increases
   (d) apparent power remains constant

NOTES

5. The value of power factor correction capacitor used is often given in:
   (a) VA
   (b) W
   (c) VAr
   (d) Ω (Xc)

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

1. List five effects of having low or poor power factor.

2. Generally, the power factor in a customer's installation should not be less than__(a) .The publication this figure is given in is the_(b)_.

3. When power factor is improved, the circuit ___(a)___ will decrease; the apparent power for the circuit will___(b)___ ; the true power for the circuit will ___(c)___ ; and the reactive power for the circuit will_(d)_.

4. For the following loads, state the power factor you would expect to find.
   (a) A 40W fluorescent lamp ballast.
   (b) A 2.4kW hot water heater.
   (c) A 1kW pool pump motor.
   (d) A 60W incandescent lamp.

5. Whilst operating at no load, the power factor of an induction is ___(a)___, but will ___(b) as the motor is loaded.

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. A 240V, 50Hz single phase inductive load operates at a constant 2.4kW input power. Determine the circuit current when:
   (a) the power factor is at 0.2 lag; (50A)
   (b) the power factor has been improved to 0.9 lag. (11.1A)

2. Draw a power triangle for a 1500W load operating at 0.5 lagging power factor, using a scale of 1mm = 50W = 50VA = 50 VAr. Also show on your power triangle the new apparent and reactive power if the power factor is improved to 0.95 lagging. (1600VA, 500VAr)

NOTES

3. For the circuit of figure 1, determine:
   (a) the supply current (scale: 1mm = 0.25A). (19.5A)
   (b) the phase angle (16.5^{o} lag)
   (c) the power factor; (0.96 lag)
   (d) the apparent power; (4.68kVA)
   (e) the true power; (4.49kW)
   (f) the reactive power. (1.33kVAr)

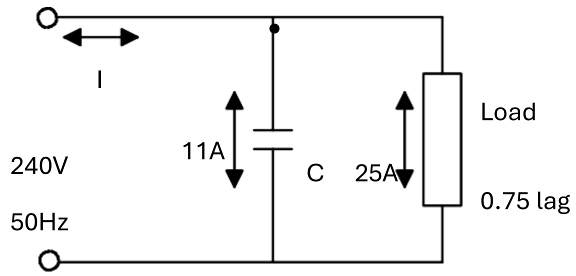

Figure 1

4. For the circuit of figure 2, determine:
   (a) the kVAr rating of a capacitor required to improve the power factor to 0.9 lag. Use a scale of 1mm = 100W = 100VA = 100VAr. (10.1kVAr)
   (b) the new value of apparent power. (3.4kVA)
   (c) the new value of circuit current. (14.2A)

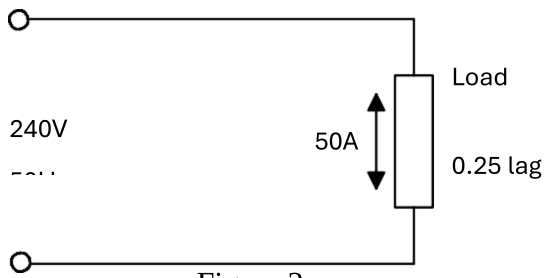

Figure 2

5. For the circuit of figure 2, determine the value of capacitance required to reduce the current to half of its original value. Use a scale of 1mm = 0.5A. (345µF)

6. A single phase 240V, 50Hz circuit draws 15A from the power supply, and operates at a lagging power factor of 0.8. Determine the kVAr rating and value of capacitance required to improve the power factor to unity. (2.16kVAr; 119μF)

Three Phase Generation

Please note the following requirements in relation to tutorial work -

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- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. One advantage of a three phase supply over a single phase supply is:
   (a) only three conductors are required for three phase systems
   (b) three phase voltages are lower than single phase voltages
   (c) three phase machines are larger for a given output power
   (d) three phase motors produce a constant torque

2. Positive phase sequence is represented by:
   (a) B-A-C
   (b) C-B-A
   (c) A-B-C
   (d) A-C-B

3. Single phase loads can be connected to a three phase distribution system that is:
   (a) delta connected with three wires
   (b) delta connected with four wires
   (c) star connected with three wires
   (d) star connected with four wires

4. When transmitting a given amount of power using a three phase system compared to a singlephase system:
   (a) more conductor material is required
   (b) less conductor material is required
   (c) the same amount of conductor material is required
   (d) a different conductor material is required

5. In a three phase alternator, the angle between the windings is:
   (a) 120°
   (b) 180°
   (c) 90°
   (d) 60°

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

The order in which the phases of a three phase supply reach their maximum value is known as the ___(1)___

Two methods of connecting a three phase supply or load are____(2)___and____(3)___

The colours used to identify the three phase conductors of a three phase system are____(4)___, ___(5)___and____(6)___

If a three phase motor is used in preference to single phase motor of the same physical size, the three phase motor will have a____(7)___power output and a higher_____(8)___

A poly phase system uses____(9)___or more phases.

If connected in star, a three phase supply will have two voltages available, known as the ___(10)___voltage (measured between an active conductor and the_____(11)___conductor) and the____(12)____voltage (measured between any two____(13)___conductors).

14. List two functions of the neutral conductor in a star connected supply.

15. Figures 1 and 2 represent the windings of a three phase alternator. Show how you would connect figure 1 in star configuration, and how would connect figure 2 in delta configuration.Also show how would connect the neutral conductor in figure 1.

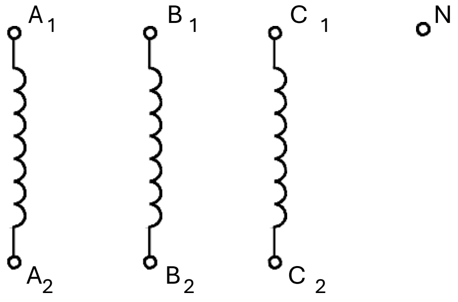

Figure 1

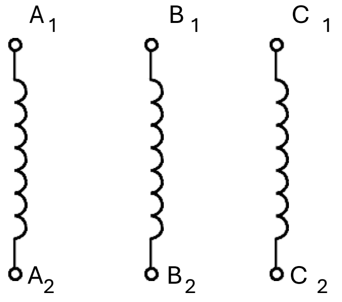

Figure 2

Both figures 1 and 2 are reproduced on page 66 for you to cut and paste to your submitted assignment sheets.

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. A three phase generator has a phase voltage of 19kV. Determine the generators line voltage ifconnected in:
   (a) star. (33kV)
   (b) delta. (19kV)

2. A three phase supply has a line voltage of 415V. Determine the supply phase voltage ifconnected in:
   (a) star. (240V)
   (b) delta. (415V)

3. A three phase generator has a maximum generated voltage of 340V. Determine the instantaneous value of voltage for all three phases when A phase is at an angle of 45° . (A phase: 240V; B phase: 88V; C phase: -328V)

****

Three Phase Star Connected Systems

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SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The line voltage of a star connected system is:
   (a) $\sqrt{3}$ Vp
   (b) $\sqrt{2}$ Vp
   (c) 0.5Vp
   (d) equal to Vp

2. The purpose of the neutral conductor in an unbalanced star connected system is to:
   (a) provide an earth point
   (b) provide a protective circuit
   (c) carry out of balance currents
   (d) reduce the supply voltage

3. In a star connected system, the phase angle between the line current and phase current is:
   (a) 120^{o}
   (b) 90^{o}
   (c) 30^{o}
   (d) 0^{o}

4. The neutral current in an unbalanced star connected load is the:
   (a) algebraic sum of the phase currents
   (b) phasor sum of the line currents
   (c) algebraic sum of the line currents
   (d) numerical difference of the phase currents

5. In a star connected system, the phase angle between the line voltage and phase voltage is:
   (a) 120°
   (b) 90°
   (c) 30°
   (d) 0°

6. If a star connected system uses $16mm^2$ active conductors and is used to supply single phaseloads, the correct size of the neutral conductor would be:
   (a) $35mm^2$
   (b) $25mm^2$
   (c) $16mm^2$
   (d) $10mm^2$

7. In a star connected supply, the neutral is connected to:
   (a) the star point
   (b) any one of the line terminals
   (c) any one of the phase terminals
   (d) where ever you like

8. The line current of a star connected system is:
   (a) $\sqrt{3}$ Ip
   (b) $\sqrt{2}$ Ip
   (c) 0.5Ip
   (d) equal to Ip

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

In a star connected supply, the neutral is normally connected to ___(1)___. This connection maintains the neutral at a reference voltage of____(2)___.

There are two voltages available in a star connected system. The____(3)___voltage is measured between any____(4)___ conductor and the neutral conductor, whilst the____(5)___ voltage is measured between any two active conductors.

6. List the five basic types of loads that can be connected to a three phase, four wire system.
A ___(7)___ load will have impedances of equal value, whilst an ___(8)___ load has impedances which are unequal.

The____(9)___currents of a star connected load are equal to line currents.

10. List two adverse effects of a disconnected or high impedance neutral on a three phase, fourwire system.

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. Three 57Ω resistors are connected in star to a three phase supply. If the voltage across eachresistor is 240V, determine the:
   (a) phase current drawn by each resistor; (I_P = 4.21A)
   (b) current in each supply line; (I_L = 4.21A)
   (c) line voltage. (V_L = 415V)

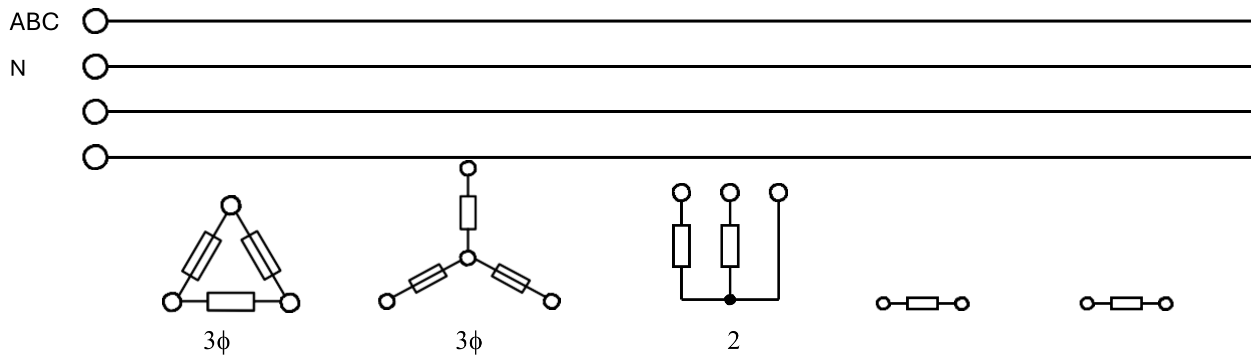
2. Three heating elements of 36Ω are connected in star to a 415V, three phase supply. Determine the:
   (a) phase voltage across each element; (V_P = 240V)
   (b) phase current in each element; (I_P = 6.67A)
   (c) current in each supply line; (I_L = 6.67A)
   (d) power in kW dissipated by each element. (P = 1.6kW)

3. Three heating elements each of 15Ω are connected in star to a 415V, 50Hz three phase, fourwire supply. Using a scale of 1mm = 0.5A, determine the value of neutral current. (I_N = 0 A)

4. A three phase, four wire system has the following single phase resistive loads connected to it:
   (a) A phase: 3A;
   (b) B phase: 2A;
   (c) C phase: 4A.
   Using a scale of 1mm = 0.1A , determine the current flowing in the neutral conductor. (I_N = 1.7A)

5. A three phase, four wire system has the following single phase loads connected to it:
   (a) A phase: a single phase motor drawing 10A at 0.9 lag
   (b) B phase: a single phase motor drawing 15A at 0.65 lag
   (c) c phase: a 2.4kW radiator
   Using a scale of 1mm = 0.25A , determine the current flowing in the neutral conductor. (I_N = 10.5A)

6. **Cut and paste** the diagram of figure 1 on your answer sheet. On the diagram of figure1correctly connect the loads as shown to the three phase, four wire supply.



ABC
N
3ϕ
3ϕ
2

Three Phase Delta Connected Systems

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets, and all work is to be completed in ink.
- In the case of multiple choice type questions, the question number and corresponding answer letter are to be written on the answer sheet.
- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. To correctly connect three windings labelled A1 - A2, B1 - B2 and C1 - C2 in delta, thewiring connections would be:

   () A2 to B1, B2 to C1 and C2 to A1
   () A1 to B1 to C1
   () A1 to B2, B1 to C2 and C1 to A2
   () B2 to C2 to A2

2. In a delta connected system, the phase angle between the line current and phase current is:() 120^{O}

   () 90^{O}
   () 30^{O}
   () 0^{O}

3. The line voltage of a delta connected system is:

   () $\sqrt{3}$ Vp
   () $Vp/\sqrt{3}$
   () 0.5Vp
   () equal to Vp

4. When connecting a delta system, a neutral conductor is not used as:() there are no out of balance currents in delta

   () a neutral connection would create a short of one active to neutral
   () two voltages can be obtained without a neutral
   () there would be no return path for the phase currents

5. In a star connected system, the phase angle between the line voltage and phase voltage is:() 120^O
   - () 90^O
   - () 30^O
   - () 0^O

6. The line current of a star connected system is:
   - () $\sqrt{3}$ Ip
   - () Ip $/\sqrt{3}$
   - () 0.5Ip
   - () equal to Ip

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

The ratio of line currents to phase currents in a delta connected system is____(1)___

2. List three commonly connected delta loads.

If a delta connected load is unbalanced the line currents will be____(3)___

If a star connected load is reconnected in delta configuration, the line currents in delta will be ___(4)___the line currents in star.

A delta connected system will always be a____(5)___wire system, whilst a star connected system can be a____(6)___wire or a____(7)___wire system.

The ratio of line voltages to phase voltages in a delta connected system is____(8)___

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. Three 47Ω heating elements are connected in delta to a 415 volt three phase supply. Determine the:
   - () phase current drawn by each resistor; (I_P = 8.83A)
   - () current in each supply line; (I_L = 15.3A)
   - () line voltage. (V_L = 415V)

2. Three heating elements of 36Ω are connected in delta to a 415V, three phase supply.Determine the:

   () phase voltage across each element; (V_P = 415V)() phase current in each element; (I_P = 11.5A)

   () current in each supply line; (I_L = 20A)

   () power in kW dissipated by each element. (P =8.3kW)

3. A 415V, delta connected three phase transformer has 20A flowing in each of its windings. Ifconnected to a delta connected three phase load, determine:

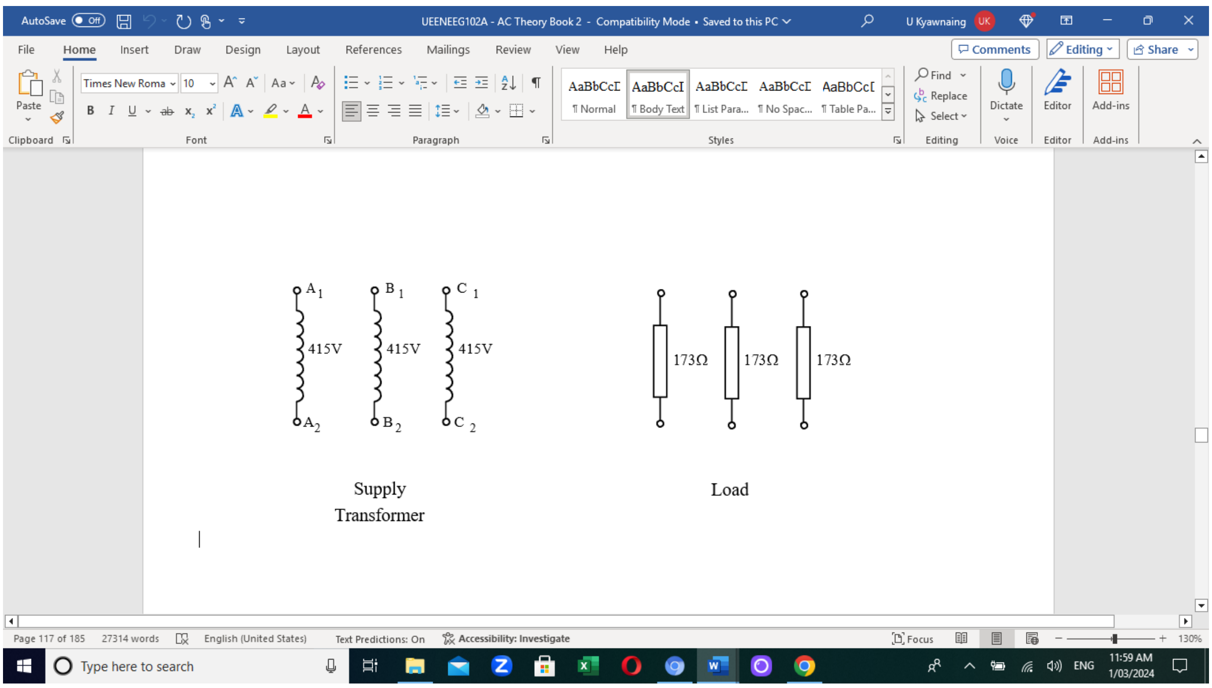
   () the current in each line; (I_L = 34.6A)

   () the impedance in each phase of the load. (Z = 20.75Ω)

4. **Cut and paste** the diagram of figure 1 on your answer sheet.

   () On the diagram of figure 1 correctly connect the supply transformer in delta and the loadin delta, then connect the load to the supply;

   () For the circuit of figure 1, determine the current flowing in the windings of the supplytransformer. (I_P= 2.39A)



Three Phase Power & Power Factor

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- In the case of short answer type questions, the question with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The minimum number of fixed wattmeters required to measure the power consumed by athree phase, four wire unbalanced system is:
   () one
   () two
   () three
   () four

2. If the phase currents and power factors are equal in a three phase system, then the system issaid to be:
   () balanced
   () unbalanced
   () star connected
   () delta connected

3. The power factor for a balanced three phase system is the ratio of:() true power to reactive power
   () apparent power to reactive power
   () true power to apparent power
   () reactive power to true power

4. The total power in a three phase system can be measured using a single wattmeter providedthe:
   - () load is balanced
   - () load is unbalanced
   - () load is star connected
   - () neutral is not connected

5. Power factor correction applied to a three phase system is
   applied to:() all three phases
   - () the phase with the largest power factor
   - () the phase with the smallest power factor
   - () any one of the three phases

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

If a three phase load is unbalanced, then either the currents or the____(1)___in all three phases of the load will be____(2)___

In a three phase system, the power consumed by one phase can be used to determine the total power if the system is____(3)___

If a three phase load is____(4)___, the power consumption of each phase must be determined separately then added together to determine the____(5)___power consumption of the system.

If a load is connected in star, the power consumed can be determined by P =____(6)___, but if the load is connected in delta, the power consumed can be determined by P =____(7)___

If a three phase system is balanced, then the power taken by one phase will be_____(8)___the total power taken by the system.

When connecting capacitors for power factor correction, the capacitors are connected in either ___(9)___or____(10)___configuration across the supply.

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. A three phase load draws 16A when connected to a 415 volt three phase supply with a 0.8lagging power factor. Determine the power consumed by the load. (9.2kW)

2. A three phase induction motor consumes 12kW at 0.759 power factor when connected to a415V, three phase supply. Determine the:
   () line current drawn by the load; (22A)
   () apparent power of the circuit; (15.8kVA)
   () reactive power of the circuit; (10.3kVAr)

3. For the circuit of figure 1, determine the:
   () total power consumed by the circuit. (4968W)
   () total reactive power for the circuit; (2130VAr)
   () total apparent power for the circuit; (5405VA)

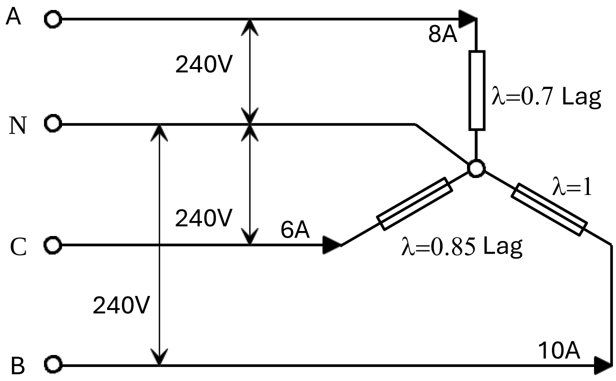

Figure 1

4. A 6.6kV, three phase delta connected induction motor takes 500kW and draws a current of50.5A. Determine the:
   () power factor of the motor; (0.866lag)
   () phase angle of the motor currents; (30^{O})
   () reactive power of the load. (288kVAr)

5. When supplied from a 132kV, three phase supply, an aluminium smelter takes 6MW whenoperating at a power factor of 0.437 lag. Determine the:
   () line current taken by the load; (60A)
   () MVAr rating of a capacitor bank required to improve the overall power factor to 0.94 lagging; (10MVAr) Scale: 1mm = 100kW = 100kVA = 100kVAr
   () capacitance per phase of a star connected capacitor bank; (1.8µF)
   () line current for the smelter when the power factor improvement is applied. (28A)

POWER MEASUREMENT AND HARMONICS

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets, and all work is to be completed in ink.
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- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter of your choice on your answer sheet.

1. The power factor of a three phase load can be determined using the two watt meter methodprovided:
   (a) the power factor is greater than 0.5
   (b) the neutral is not connected
   (c) the load is balanced
   (d) there is no current in the middle phase

2. An indication that harmonics are present in a three phase supply system would be:
   (a) erratic motor behaviour
   (b) low transformer currents
   (c) low nuetral currents
   (d) lower power consumption

3. When measuring power using the two watt meter method, if W1 reads zero, and W2 reads100W, the circuit power factor will be:
   (a) unity
   (b) zero
   (c) 0.5 leading
   (d) 0.5 lagging

4. When measuring a balanced three phase load using the two watt meter method, if bothwattmeter readings are equal, the power factor is equal to:
   (a) unity
   (b) zero
   (c) 0.5 leading
   (d) 0.5 lagging

5. To measure the total power in any three phase unbalanced load, the minimum number ofwattmeters required is:
   (a) 1
   (b) 2
   (c) 3
   (d) 4

SECTION B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

List the relative wattmeter readings (ie comparing W1 to W2 etc..) that will give the following power factor indications when using the two wattmeter method of measuring power:

1 Unity

2 0.7 leading

3 0.5 lagging

4 0.25 leading

5 0.1 lagging

6. Neatly reproduce the diagram of figure 1 on your answer sheet, then complete the circuit of figure 1 to show how you would connect the circuit to use one wattmeter to measure the total power for the circuit.

7. Neatly reproduce the diagram of figure 1 on your answer sheet, then complete the diagram to show how you would cconnect the circuit to use two wattmeters to measure the total power for the circuit.

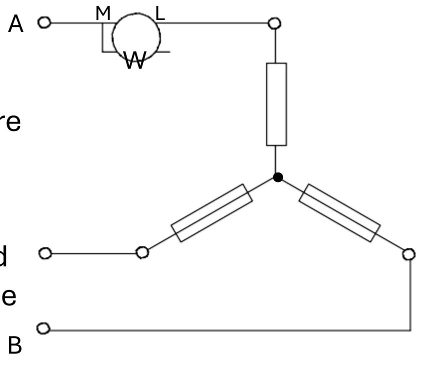

Figure 1

The frequency of a fourth harmonic with a fundamental frequency of 50Hz is____(8)___

9. List four symptoms that would indicate the presence ofharmonics in a three phase supply system.
The term “triplens” is used to describe harmonics that are the____(10)___

SECTION C

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. A single wattmeter is connected to A phase of a balanced 415V, three phase star connected heating load and is used to measure the total power consumption. If the wattmeter indicationis 1500W, determine the:
   (a) total power consumed by the load (4.5kW)
   (b) impedance of each phase of the load. (38.3Ω)

2. A balanced, delta connected induction motor is supplied from a three phase 415V supply. If the line current to the motor is 30A, and a single wattmeter connected to C phase indicates 4.5kW, determine the:
   (a) apparent power of the supply; (21.56 kVA)
   (b) total power taken by the load; (13.5 kW)
   (c) power factor and phase angle of the load; (0.626 lag, 51.3° lag)
   (d) reactive power of the load; (16.8 kVAr)
   (e) impedance of each phase of the load. (23.9Ω)

3. A 415V, inductive three phase load has its total power consumption measured using the twowattmeter method. If W1 indicates 250W and W2 indicates 1000W, determine the:
   (a) total power taken by the load; (1250W)
   (b) phase angle for the load; (46.1° lag)
   (c) factor of the load; (0.693 lag)

4. A 415V uses the two wattmeter method to measure its total power consumption. If W1indicates -750W and W2 indicates 2 kW, determine:
   (a) the Total power supplied to the load; (1250W)
   (b) the Power factor for the load; (0.254 lead)
   (c) the Line current for the load; (6.85A)
   (d) the Impedance of each phase of the load if the load is star connected.

   (35Ω)Explain why the power factor is leading from these results.

****

Star-Delta Interconnected Systems

Please note the following requirements in relation to tutorial work -

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- In the case of short answer type questions, the question and part number with your word or phrase choice is to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.

SECTION A

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

1. Refer to questions 2 & 3 below when setting your answer to this question. Draw 2 circuit diagrams, one for a star connected load and one for a delta connected load. Fully label your diagrams to include:
   (a) line and phase currents;
   (b) line and phase voltages;
   (c) phase impedance's;
   (d) a single wattmeter to measure A phase power;
   (e) labelling of the line terminals supplying each load.

2. Below your circuit diagram for a star connected load, complete a table to show how youwould determine the following:
   (a) phase current;
   (b) line current;
   (c) line voltage;
   (d) total power for a balanced load;
   (e) total power for an unbalanced load;
   (f) current in the neutral conductor.

3. Below your circuit diagram for a delta connected load, complete a table to show how youwould determine the following:
   (a) phase current;
   (b) line current;
   (c) line voltage;
   (d) total power for a balanced load;
   (e) total power for an unbalanced load.

4. Describe the effect of a phase reversal in a:
   (a) star connected supply;
   (b) a delta connected supply.

5. Describe how you can test for a phase reversal in a delta connected load. Accompany youranswer with a circuit diagram.

6. Describe the effect of the loss of one supply line in a:
   (a) star connected supply;
   (b) delta connected supply.

SECTION B

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

1. For the circuit of figure 1, if the load representsheating elements, determine the:
   (a) load phase current; (19.2A)
   (b) line current supplying the load; (15.9A)
   (c) total power consumed by the load. (11.48kW)

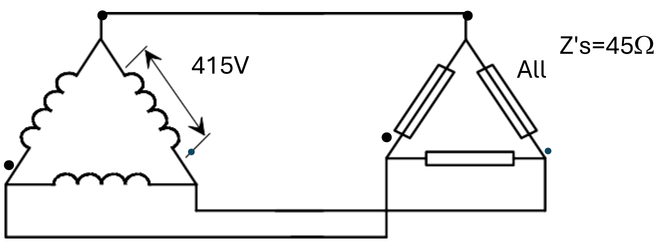

Figure 1

2. A star connected 415V emergency generator supplies a delta connected three phase induction motor. If the motor winding impedance's are 20Ω each and the motor operates at a lagging power factor of 0.773, determine the:
   (a) phase currents in the motor; (20.75A)
   (b) phase currents in the generator; (36A)
   (c) total power consumed by the load (20kW)

3. For the circuit of figure 2, determine the:
   (a) voltage across each phase of the load;(V_B=V_{BC}=415V; V_A=V_C=207.5V)
   (b) current in each phase of the load; (I_A=I_B=2.5A; Ic=5A)

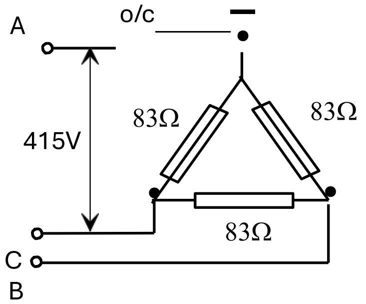

Figure 2

4. For the circuit of figure 3, determine the:
   (a) line voltage output of the transformersecondary; (200V)
   (b) phase voltage of the heating load; (115V)
   (c) line current from the transformer to the load; (5A)
   (d) power used by the load, assuming thepower factor is unity (1.732kW)

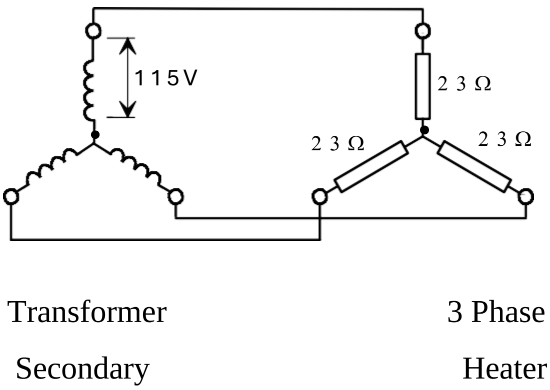

Figure 3

5. A delta connected transformer secondarysupplies a star connected inductive load. The power consumption of the load is measured at 15kW at a power factor of 0.695. If the phase current of the load is 30A, determine the:
   (a) line voltage output of the transformer; (415V)
   (b) phase voltage of the load; (240V)
   (c) phase angle for the load; (46° lag)
   (d) current in the transformer windings. (17.32A)

****

Tutorial - Magnets and Magnetism

NAME:-

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets. Put your first 7 last names on each sheet.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answerletter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation typequestions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

Magnets are classified as either______magnets or_______magnets.

(a) temporary, electro-.

(b) electro-, induced

(c) permanent, temporary

(d) induced, temporary

Magnetic properties state that like magnetic poles______each other, whilst_______poles ______ each other.

(e) repel, unlike, attract.

(f) attract, unlike, repel.

(g) repel, equal, attract.

(h) repel, neutral, attract.

The north pole of a magnet is said to be:

(i) north repelling, repelling the earth's north magnetic pole.

(j) north seeking, seeking the earth's north magnetic pole.

(k) south seeking, seeking the earth's south magnetic pole.

(l) north repelling, seeking the earth's south magnetic pole.

A an example of a material which will have a magnetic field induced into it whilst under the influence of an adjacent magnet is:

(m) copper.

(n) wood.

(o) soft iron.

(p) aluminium.

The opposition of a material to becoming magnetised is known as:

(q) impedance.

(r) reluctance.

(s) resistance.

(t) inductance.

A piece of_______will have a lower amount of residual flux when compared to a piece of _____ when the magnetic influence is removed.

(u) hard steel, soft iron.

(v) soft iron, copper.

(w) hard steel, copper.

(x) soft iron, hard steel.

Magnetic flux is measured in:

(y) Webers.

(z) Teslas.

(aa)

Henries

.(bb) Ohm's.

Flux density is a measure of the amount of :

(cc) magnetic flux.

(dd) reluctance per unit area.

(ee) magnetic flux per unit area.

(ff) inductance flux per unit area.

Flux density is measured in:

(gg) Henries.

(hh) Ohm's.

(ii) Webers.

(jj) Teslas.

Retentivity is an indication of how much:

(kk) magnetism is required to magnetise a material.

(ll) residual magnetism a material will have.

(mm) magnetism is required to de-magnetise a material.

(nn) residual magnetism a material will lose.

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

The laws of magnetism state that magnetic lines of force never_______, they are _____ and unbroken, they can be_______indefinitely, and are said to flow externally from the ______ to the_______.

The greatest concentration of flux in a magnet will be at the _______

Laws of magnetism state the_______poles repel, and_______will_______each other.

List two materials that are:

(oo) ferromagnetic.

(pp) non-magnetic.

Reproduce the diagram of figure 28 on your answer sheet using drawing instruments to complete your drawing. Show the field pattern produced by the permanent magnet, and label all magnetic poles.

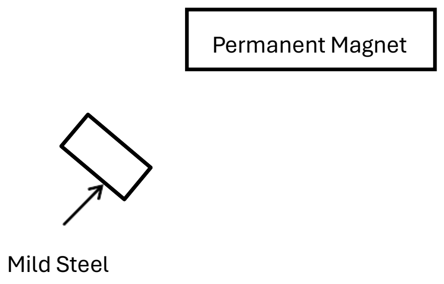

Figure 28

Many of the following equations will be encountered in work on magnetism. Transpose the equations as required.

(qq) MMF = I x N, I = ? (Note: mmf stands for "magneto-motive-force")

(b) $H = \frac{I \times N}{l}$ N = ?

(c) $\Phi = \frac{mmf}{S}$ S = ?

(d) $B = \frac{\Phi}{A}$ Φ = ?

(e) $L = \frac{\mu \times N^2 \times A}{l}$ N = ?

(f) $e = N \times \frac{\Delta\Phi}{\Delta t}$ N = ? (Note: Δ (delta) means a "change in" ie change in time)

(g) $L = N \times \frac{\Delta\Phi}{\Delta I}$ ΔI = ?

SECTION C

The following problems are to be solved with the aid of a calculator. All equations and working are to be shown.

The flux produced by a magnet is 10mWb. Determine the flux density if the area of the pole is 250 mm^2 (40T)

For the magnet in the previous question, determine the flux density away from the pole if the flux now spreads out to an area of 600 mm^2. (16.7T)

Determine the flux of a magnet if the flux density at the poles is 2T, and the area of the poles is $300mm^2$. ($600\mu Wb$).

****

TUTORIAL – ELECTROMAGNETISM

NAME:- ____

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- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The magnetic field surrounding a single current carrying conductor is:

   (a) circular and independent of the direction of current flow.

   (b) circular and dependent of the direction of current flow.

   (c) axial and independent of the direction of current flow.

   (d) axial and dependent of the direction of current flow.

2. The direction of the magnetic field around a single current carrying conductor can bedetermined by:

   (a) Fleming's right hand rule.

   (b) Fleming's left hand rule.

   (c) the right hand conductor rule.

   (d) the right hand solenoid rule

3. In a single current carrying conductor, current flowing towards the viewer can be shown by a____, whilst current flowing away from the viewer can be shown by a
   _______ .

   (a) cross, dot.

(b) cross, asterisk.

(c) dot, asterisk.

(d) dot, cross.

4. If two single current carrying conductors adjacent to each other have currents flowingthrough them in opposite directions, then a/an_____force exists between the two coils.

   (a) attraction.

   (b) repulsion.

   (c) magneto motive

   (d) inductive.

5. The magnetic field around a copper conductor can be increased by:

   (a) winding the conductor into a coil.

   (b) increasing the current through the conductor.

   (c) inserting an iron bar into the wound.

   (d) all of the above

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

6. State the type of electromagnetic action employed in the following practicalapplications:

   (a) circuit breakers.

   (b) relays and contactors.

   (c) magnetic chucks and electric crane brakes.

7. State what type of electromagnetic device would be used in the following practicalapplications:

   (a) to break an arc on the opening of a circuit breaker.

   (b) measure both A.C. and D.C. currents.

   (c) anti shop lifting devices.

   (d) measure wheel speed.

8. Winding a conductor into a coil has the effect of ____

9. The two effects of current that are always present when current flows through aconductor are the________________effect and___effect

10. What is the force that exists between two adjacent conductors that have currentsflowing in:

(a) opposite directions ?

(b) the same direction ?

11. State the rule used to determine the magnetic field around a single conductor, andbriefly describe how you would apply that rule.

12. State the rule used to determine the magnetic field around a coil, and briefly describehow you would apply that rule.

13. Describe a method you would use to:

(a) magnetise a piece of magnetic material.

(b) de-magnetise a piece of magnetic material

14. State three advantages of using an electromagnet over a permanent bar magnet.

15. Draw a cross sectional view of a conductor. On your diagram, clearly mark howwould show current flowing towards the viewer through the conductor .

16. Draw a cross sectional view of a conductor. On your diagram, clearly mark howwould show current flowing away from the viewer through the conductor .

17. For the circuit of figure 27, use the right hand solenoid rule to determine which end ofthe electromagnet will be the north pole.

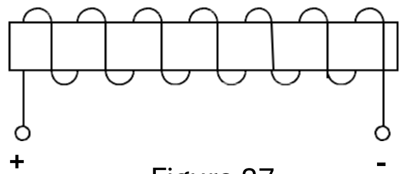


Figure 27.

18. For the circuit of figure 28, use the right hand solenoid rule to determine which end ofthe electromagnet will be the north pole.

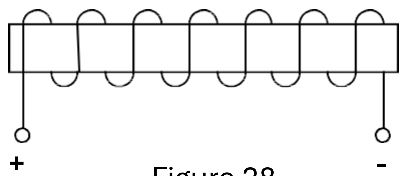


Figure 28.

19. For the circuit of figure 29, use the right hand solenoid rule to determine which end ofthe electromagnet will be the north pole.

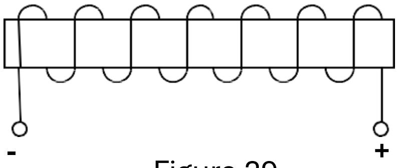


Figure 29.

20. Two parallel conductors have currents flowing through them in opposite directions.Draw a sectional view of the two conductors, and show the following:

(a) the relative current directions in each conductor;

(b) the correct magnetic field around each conductor;

(c) the resultant magnetic field of the two conductors together;

(d) the direction of the force exerted between the conductors.

SECTION C

The following problems are to be solved with the aid of a calculator. All equations and working are to be shown.

21. A coil of 120 turns has a current of 250mA flowing through it. Determine themagneto motive force produced by the coil. (30At)

22. If the power supply for question 1 has a current limitation of 120mA, how many turnsmust the coil be varied by to maintain the same magneto motive force? (Add 130 turns)

23. How much current must flow in a coil of 1000 turns to produce a magneto motiveforce of 125At? (125mA)

24. The coil as shown in figure 30 has various *tapping's* to vary the magneto motive force produced by the coil. If the number of turns per tapped section is 35 turns, determine the magneto motive force produced by the various tapping's using position "**1**" as a reference. The current through all of the coil has been measured at 2.5 amperes . (1-2: 87.5At;1-3: 175At;1-4: 262.5At;1-5: 350At)

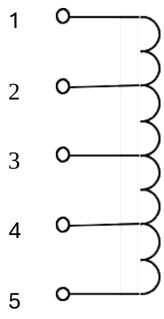


Figure 30.

****

TUTORIAL - PART 1 - MAGNETIC CIRCUITS

NAME: ______________________________

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pagesstapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answerletter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation typequestions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

[1] The magneto motive force produced by a coil depends on:

a) the number of coil turns and the length of the magnetic circuit
b) the coil current and the C.S.A of the magnetic core
c) the length of the magnetic circuit and the core reluctance
d) the number of coil turns and the coil current

[2] The flux set up by a coil depends on the_____produced by the coil and ______ of the iron core:

a) mmf, reluctance.
b) magnetising force, C.S.A.
c) mmf, magnetising force.
d) mmf, flux density.

[3] The flux surrounding a coil is______to the coil current and______to the reluctanceof the core.

a) proportional, proportional
b) inversely proportional, inversely proportional
c) inversely proportional, proportional
d) proportional, inversely proportional

[4] A material with a high permeability will easily______magnetic flux.

a) concentrate
b) oppose
c) generate
d) produce

[5] A material with a high reluctance will______the establishment of magnetic flux.

a) concentrate
b) generate
c) control
d) oppose

[6] In a magnetic circuit, reluctance is____to the length of the core and______to the cross sectional area of the core.

a) proportional, proportional
b) inversely proportional, inversely proportional
c) inversely proportional, proportional
d) proportional, inversely proportional

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

Flux density is a measure of the_________of magnetic flux for a given_________, and is measured in_________.

To increase the flux produced by a coil, either increase the coil_________or the number of coil_________, or decrease the core_________.

Materials with a relative permeability of 1 are classified as____(a)___, whilst materials with a high to very high relative permeability are classified as____(b)___

μ_0 is the permeability of_________, μ_r is the_________of a material, whilst μ is the _________ of a material.

If a material has a high_________it is difficult to magnetise.

When comparing a magnetic circuit to an electrical circuit,_________is the equivalent of an emf,_________is the equivalent of circuit current and_________is the equivalent of circuit resistance.

The best size and shape for a magnetic core would be one with a________length and a large_________.

Neatly reproduce (or cut and paste) the diagram of figure 1 on your answer sheet, then label those parts identified with an arrow.

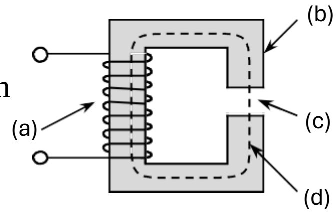


Figure 1.

SECTION C

The following problems are to be solved with the aid of a calculator. All equations and working are to be shown.

A coil of 150 turns has a current of 3.5A flowing through it. Determine the magneto motive force produced by the coil. (525At)

Determine the flux produced by a coil of 1000 turns when 1.5 amperes flows through it. The reluctance of the magnetic circuit is determined to be 45 000At/Wb.

(33.3mWb)

Determine the current that must flow through a coil of 1500 turns to produce a flux of 15mWb. The reluctance of the magnetic circuit is determined to be 5 000At/Wb.

(0.05A)

Determine the flux density at the poles of an electromagnet which produces a flux of 15mWb if the area of the poles is $200mm^2$. (75T)

A magnetic circuit has a core area of $250mm^2$ and a flux density of 2T. If the reluctance of the core is 60 000 At/Wb, determine the current flowing through the coil of 600 turns. (50mA)

An electromagnet has a core length of 400mm, is wound with 2000 turns and carries a coil current of 200mA. Determine the magnetising force of the magnetic circuit.

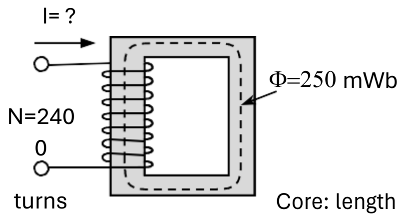
(1000At/m)

Determine the current flowing in a coil of 600 turns which produces a magnetising force of 2000 At/m in a core 150mm long. (500mA)

A magnetic core is 300mm long with a cross sectional area of 50mm^2 and has a permeability of 125.7×10^{-3}. Determine the reluctance of the core. (47,732 At/Wb)

For the circuit of figure 2, determine the coil current for the conditions shown.

(625mA)



Core: length = 150mm

C.S.A.= 250mm^2

Permeability = 100×10^{-3}

Figure 2.

Tutorial – Part 2 - Magnetisation Curves and Materials

NAME: ____

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

2. Hysterisis loss is due to:

   a) high reluctance.
   b) low permeability.
   c) high flux density.
   d) residual magnetism.

3. A B-H curve shows how the______changes for changes in______.

   a) material reluctance; mmf
   b) flux density; magnetising force
   c) magnetising force; flux density
   d) flux; reluctance

4. The B-H curve which is shown as a straight line would be that for:

   a) air
   b) cast iron
   c) mild steel
   d) silicon steel

5. The lagging of changes in magnetic flux density behind changes in magnetising forceis known as:

   a) eddy current loss
   b) permitivity
   c) hysterisis
   d) reluctance

6. ______ occurs when the flux density of a material cannot be increased further forincreases in magnetising force.

    a) Residual magnetism
    b) Coercive force
    c) Retentivity
    d) Saturation

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

7. A magnetisation curve shows the relationship between______and_________for magnetic materials.

8. When the magnetisation____________is reduced to zero, any magnetic flux remaining in the material is known as___________, and the force required to reducethis_______to zero is known as the_____________.

9. ______________ steel is commonly used in transformers and electric motors due to itslow_________.

10. This page may be removed from this workbook and handed in as part of thisassignment. On the diagram of figure 3:

    a) identify and name the characteristic curve;
    b) identify and fully label the horizontal and vertical axes;
    c) show and label on the diagram the following:

        - the saturation points.
        - the amounts of residual magnetism
        - the amounts of coercive force
        - from the text, draw the comparative hysterisis loop for silicon steel.

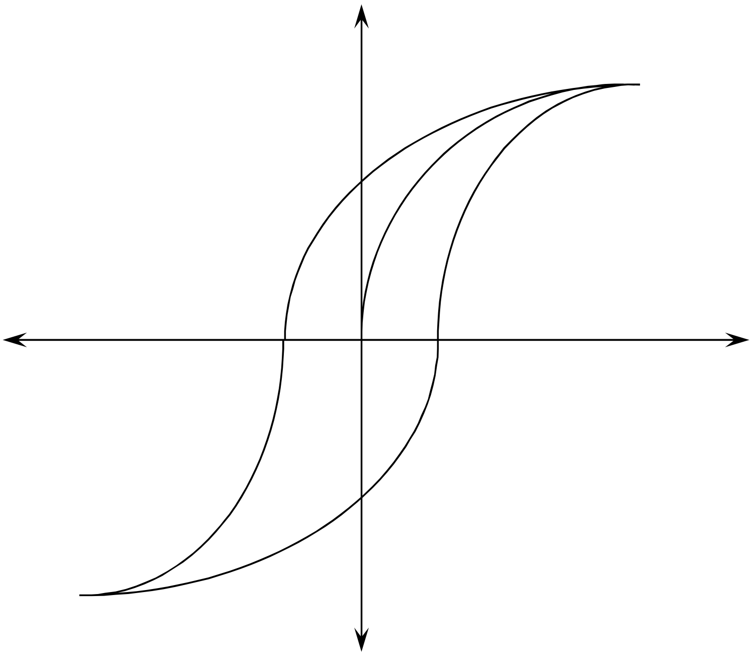


Figure 3

11. Table 2 represents the results of magnetising the field of a generator and the resultingfield flux.

Table 2								
Magneto motive Force (At)	0	500	1000	1500	2000	3000	4000	6000
Flux (mWb)	5	17.5	32	45	57.5	72	75	78

12. On the 5mm grid on page 34, draw vertical and horizontal axes, and clearly label eachaxis and title the graph,

a) Using a scale of 10mm = 500At and 10mm = 5mWb, plot and neatly drawthe curve from the results of table 1, using a curve of best fit,

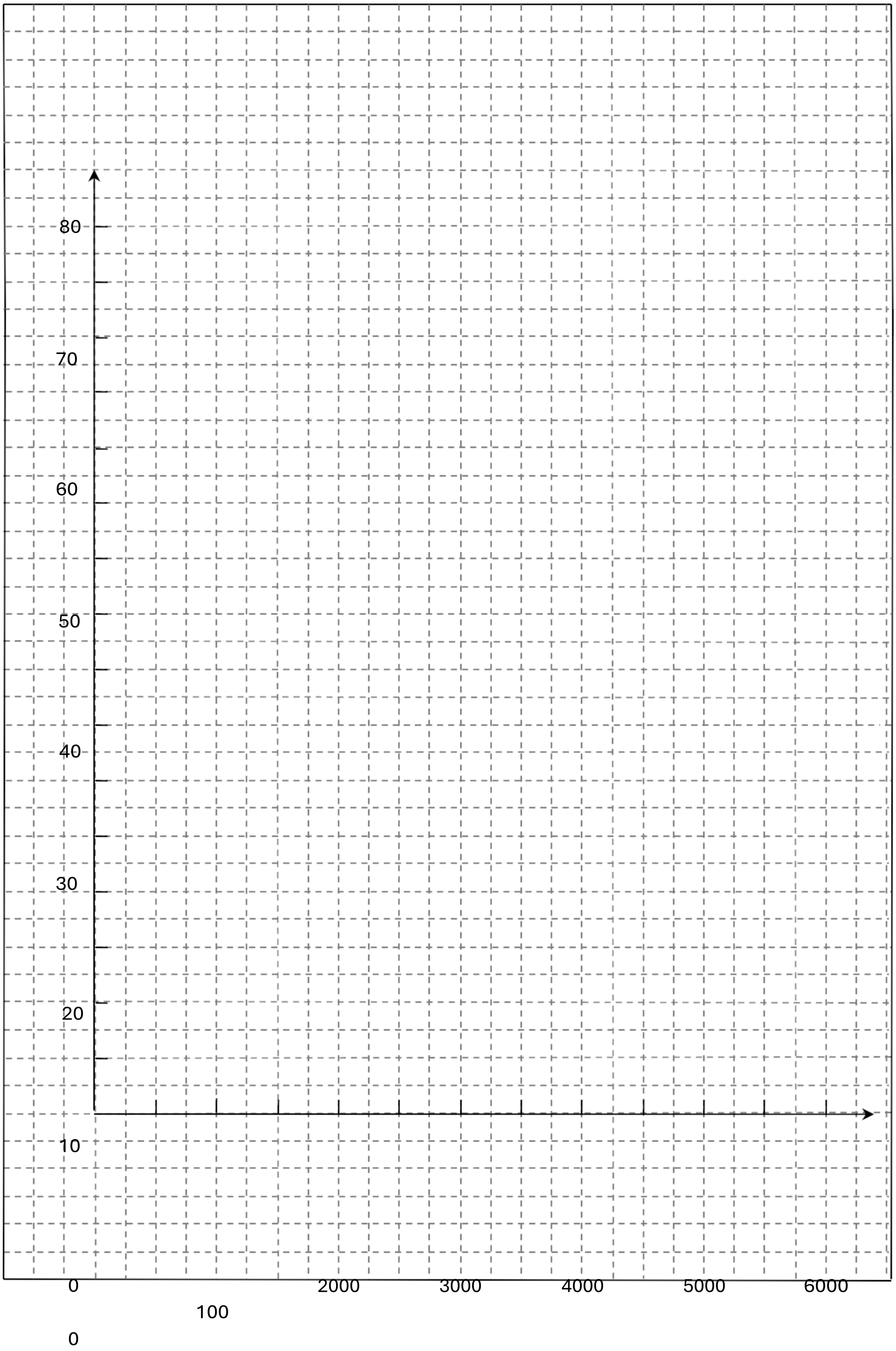
b) On the graph, show the useful region of the curve, the knee of the curveand the point of saturation.

c) From the graph determine

- the flux required for mmf's of 2500 At and 5000 At;
- the mmf's required for a flux of 40mWb and 65mWb.

NOTE:

Include the 5mm grid on page 34 as part of your submitted assignment.



TUTORIAL - ELECTROMAGNETIC INDUCTION

NAME: ____

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pagesstapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answerletter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation typequestions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. If a conductor in a magnetic field moves parallel to the magnetic field , the inducedvoltage will be__volts.

   (a) a maximum

   (b) alternating

   (c) an average

   (d) zero

2. Fleming's Right Hand rule is used to determine the direction of the:

   (a) magnetic field around a solenoid

   (b) induced currents in a conductor

   (c) magnetic field around a single conductor

   (d) force exerted on a current carrying conductor

3. The value of emf induced into a conductor is dependent upon the___density, _______ of conductor and_______of the conductor.

   (a) conductor; length; velocity

   (b) flux; type; velocity

   (c) flux; length; velocity

   (d) flux; length; material

4. Maximum emf is induced in a conductor when it moves through a magnetic field atan angle of intersection of:

   (a) 0^{o}

   (b) 45^{o}

   (c) 90^{o}

   (d) 180^{o}

5. If the rate at which a conductor moves through a magnetic field is increased, theinduced emf will:

   (a) decrease.

   (b) remain the same.

   (c) alternate.

   (d) increase.

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

6. In Flemings Right Hand Rule, the thumb indicates________; the first finger indicates _________ and the middle finger indicates__________.

7. A cross shown in a cross sectional view of a conductor shows______, whilst a dotshows______.

8. The polarity of an emf induced into a conductor depends on the______of the magnetic field and the________of the conductor.

9. To find the emf induced into a conductor, the equation to use is______, where “e” is the_________, measured in________, “B” is the__________measured in_________, “ l ”is the_________measured in_________and “ v ” is the__________measured in _________.

10. If the rate at which a conductor cuts across a magnetic field is increased, the value ofthe_will__________.

11. **Neatly** reproduce (or cut and paste) the diagram of figure 21 on your answer sheet.For the diagram of figure 21;

   (a) draw the magnetic field pattern for the bar magnet;

   (b) determine the polarity for the terminals **"A"** and **"B"** if the bar magnet ismoved into the coil in the direction as shown; and

   (c) describe the method you used to determine the polarity of the terminals.

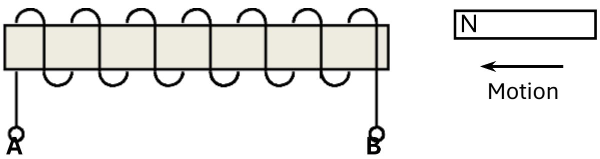


Figure 21.

Section C:

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

12. A conductor 250mm long moves at right angles with a velocity of 20m/s through a magnetic field with a flux density of 1.5 Tesla. Determine the emf induced in the conductor. (7.5V)

13. For the conductor in question 1, what would need to be increase in flux density to increase the voltage to 12V? (0.9T)

14. Determine the velocity of a conductor of 200mm length which is moving at a uniform speed through a magnetic field of 1.25 Tesla flux density at right angles to produce a voltage of:

    (a) 1.5V (6m/s)

    (b) 10V (40m/s)

    (c) 500mV (1m/s)

15. Determine the flux density of a magnetic field if a conductor 25mm long cuts throughthe flux at right angles with a velocity of 15m/s to produce a voltage of 6V.

(20T)

16. A coil of 150 turns is lined by a flux of 300mWb. If the flux is reduced to 100mWb in100mS, determine the voltage induced in the coil. (300V)

17. The diagram of figure 22 represents atransformer with input (primary) and output (secondary) turns as shown. The coils are linked by a common core flux of 25mWb, which is reduced to zero in 5mS. Determine the voltage induced in both coils. (V_1= 3kV,V_2=250V)

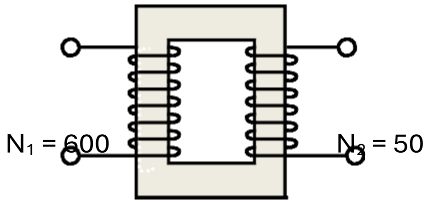


Figure 22.

TUTORIAL - MEASURING INSTRUMENTS

NAME: ____

Please note the following requirements in relation to tutorial work -

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- All relevant equations and working are to be shown in the case of calculation typequestions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings arenot to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. An ammeter has a_______resistance and is connected in_____with the load.

   (a) high, series

   (b) low, series

   (c) high, parallel

   (d) low, parallel

2. A voltmeter has a_______resistance and is connected in_____with the load.:

   (a) high, series

   (b) low, series

(c) high, parallel

(d) low, parallel

3. The moving coil meter is_______and measures_______:

(a) polarised, A.C. only.

(b) non polarised, D.C. only.

(c) non polarised, D.C. or A.C.

(d) polarised, D.C. only.

4. The moving iron meter is_______and measures_______:

   (a) polarised, A.C. only.
   (b) non polarised, D.C. only.
   (c) non polarised, D.C. or A.C.
   (d) polarised, D.C. only.

5. The deflecting torque in an analogue meter is produced by.

   (a) springs
   (b) Lenz's law
   (c) the coil current
   (d) an air dashpot

6. In the permanent magnet meter the current coil_____and the scale is________.

   (a) is stationary, linear
   (b) moves, linear
   (c) is stationary, non-linear
   (d) moves, non-linear

7. In the moving iron meter the current coil______and the scale is________.

   (a) is stationary, linear
   (b) moves, linear
   (c) is stationary, non-linear
   (d) moves, non-linear

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

8. The three torques in analogue meters are the_________torque, which moves theneedle upscale from zero, the_______torque, which moves the needle back to zero, and the_________torque, which only has an effect when the needle is ____________.

9. In the electrodynamometer, which measures_________, the____________coil is stationary, while the moving coil measures the_____________in the circuit.

10. The range of the moving___________meter, which is used on currentcircuits, may be extended using an instrument transformer.

11. The sensitivity of a voltmeter is measured in__________per____________.

12. A higher resistance___________meter would have a larger___________effect on acircuit when inserted into the circuit than a lower resistance meter.

13. A clip on DC ammeter uses the__________effect device to measure the ___________ produced by the current in the conductor.

Section C:

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

14. A galvanometer with a resistance of 17.5 ohms has a full scale deflection current of 2.4 milli amperes. Determine:

    (a) the full scale deflection voltage. (42mV)

    (b) the resistance of the shunt required to use the meter as a 100mA ammeter.(0.2126Ω)

    (c) the resistance of the multiplier if the meter is used as a 100V voltmeter.(41.65kΩ)

    (d) the sensitivity of the voltmeter. (416.7Ω/V)

15. A moving iron meter movement requires 3200 ampere turns to indicate full scale deflection. If the meter is to be used as a 5 ampere AC ammeter how many turns arerequired on the current coil? (640 turns)

16. An ammeter scaled 0 to 150mA is used with the appropriate shunt to measure a full scale current of 25 amperes. If the scale reading is 96 milliamperes what is the currentflowing in the circuit?(16A)

17. A galvanometer with a full scale deflection current of 2 milliamperes has a full scaledeflection voltage of 6 millivolts. Determine:

    (a) the resistance of the coil in the galvanometer. (3Ω)

    (b) the total current in the circuit when connected with a 0.125Ω shunt (thegalvanometer shows full scale deflection). (50mA)

    (c) the total current in the circuit when the meter indicates a deflection equivalentto 1.8 milliamperes going through the meter movement. (45mA)

(d) the current in the shunt from (c) above (43.2mA)

18. Calculate the sensitivity in ohms per volt for moving-coil instruments having thefollowing full scale deflection values.

(a) 50 μA. (20kΩ/V)

(b) 500 μA (2kΩ/V)

(c) l

mA.

(1kΩ/V)

(d) 10

mA.

(100Ω/V)

THE IDEAL TRANSFORMER

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

The core flux in a double wound transformer cuts the -

a) primary winding only
b) secondary winding only
c) primary winding on one half cycle and the secondary winding on the other halfcycle
d) primary and secondary windings simultaneously

The secondary voltage of a transformer is produced by -

a) electrostatic induction
b) current conduction
c) mutual induction
d) self induction

The number of primary winding turns on a transformer is determined by the -

a) supply frequency, voltage and core flux
b) primary current and voltage
c) impedance of the secondary load
d) frequency of the supply only

If a double wound transformer having a voltage ratio of 2:1 is supplied with a 50Hz sine wave to the primary winding, the frequency of the secondary output will be -

a) 25Hz sine wave
b) 25Hz distorted wave
c) 50Hz sine wave
d) 50Hz distorted wave

The number of primary turns on a transformer is governed by the -

a) secondary current
b) primary current
c) primary voltage
d) required ratio of transformation

In an isolation transformer the -

a) secondary voltage is greater than the primary voltage
b) primary voltage is greater than the secondary voltage
c) primary is equal to the secondary voltage
d) primary and secondary voltages are connected to oppose one another

In a step-down transformer the -

a) secondary voltage is greater than the primary voltage
b) primary voltage is greater than the secondary voltage
c) primary is equal to the secondary voltage
d) primary and secondary voltages are connected to assist one another

If the secondary current of a voltage transformer is greater than the primary current, the transformer is known as a/an -

a) isolation transformer
b) step-down transformer
c) step-up transformer
d) auto transformer

The transfer of energy from primary to secondary of a transformer is achieved via -

a) self induction
b) electrostatic induction
c) current conduction
d) mutual induction

As secondary load is increased, the primary current of a transformer -

a) decreases in proportion to the load
b) remains constant
c) increases
d) decreases by a small amount

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

Two coils having mutual inductance are said to be______(1)_____.

A transformer that has more turns on the secondary winding than the primary winding is called a______(2)_____transformer.

A transformer in which the secondary voltage is less than the primary voltage is called a _____(3)_____transformer.

A transformer in which the primary and secondary voltages are equal, is called an _____(4)_____transformer.

Because a transformer has no moving parts it is known as a______(5)_____machine.

The primary winding of a transformer is acted upon by two voltages, the applied voltage and the emf of______(6)_____induction.

The voltage induced in the secondary of a transformer is known as the emf of _____(7)_____induction.

If nearly all the flux produced by the primary cuts the conductors of the secondary, the two windings are said to be______(8)_____coupled.

The primary and secondary windings of a transformer can be identified by the fact that the primary is connected to the______(9)_____and the secondary is connected to the _____(10)_____.

When the high tension winding is the primary, the transformer is called a______(11)_____ transformer.

When the low tension winding is the primary, the transformer is called a______(12)_____ transformer.

The ratio of primary voltage to secondary voltage is called the ratio of______(13)_____.

If the effects of resistance are neglected, the primary induced voltage______(14)_____the primary applied voltage.

The ratio of primary turns to secondary turns is called the______(15)_____ratio.

The magnetic flux in the core of a transformer is essentially______(16)_____.

SECTION C

1. The primary winding of a 440/55V transformer has 400 turns. How many turns arethere on the secondary winding? (50 turns)
2. 240V is applied to the primary winding of a transformer having 1100 turns. If thesecondary has 900 turns, calculate the secondary voltage. (196.3V)
3. A transformer has a turns ratio of 1000:50. Determine the secondary voltage if 240Vis applied to the primary. (12V)
4. A 240/32V transformer has a primary current of 0.4A. Calculate the current in thesecondary winding. (3A)
5. A single phase transformer steps down from 415V to 32V. Calculate the primarycurrent if the secondary current is 2A. (0.154A)
6. A single phase 240/32V transformer has 300 primary turns and takes a primarycurrent of 1A. Determine the -

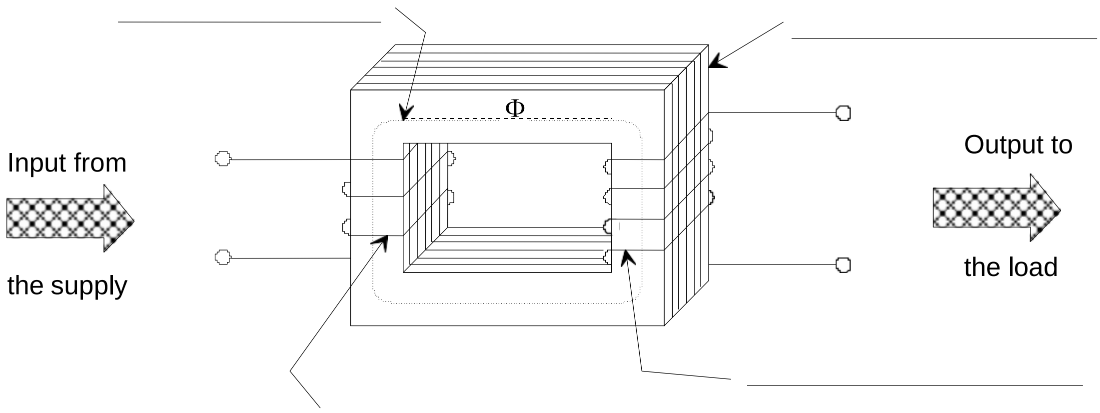
   a) secondary turns (40 turns)

   b) secondary current (7.5A)

7. A transformer is wound with 220 turns on the primary and 40 turns on the secondary.The maximum core flux is 0.045Wb and the supply frequency 50Hz. Determine the -
   a) primary voltage (2198V)
   b) secondary voltage (399.6V)
   c) transformation ratio (5.5:1)
8. A transformer with a core flux of 25mWb has a primary winding of 1000 turns and asecondary of 1500 turns. Calculate the secondary voltage if the supply frequency is 50Hz. (8325V)
9. The maximum flux of a 50Hz transformer is 0.001Wb. If the primary is wound with1080 turns, find the applied primary voltage and then calculate the number of turns required for a 15V secondary. (239.8V, 67.6 turns)
10. A single phase transformer is wound with 80 secondary turns and the primary voltageis 240V. The core flux is 2mWb at a frequency of 50Hz. Determine the -
    a) secondary voltage (35.5V)
    b) primary turns (540.5 turns)
    c) transformation ratio (6.75:1)
11. A 300/32V, 50Hz single phase transformer has 600 primary turns. Determine themaximum value of core flux. (2.25mWb)

SECTION D

1. Redraw the transformer shown in figure 1 then identify the various parts.



THE PRACTICAL TRANSFORMER

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. Practical transformer and ideal transformers differ, in that the practical transformerhas -

   a) a perfect transformation ratio
   b) losses
   c) zero hysteresis loss
   d) a better iron loss

2. The core of a transformer is laminated to -

   a) reduce hysteresis loss
   b) reduce eddy current loss
   c) enhance the coupling between windings
   d) make core construction simpler

3. In a transformer, sections of both primary and secondary windings are usually woundon each limb to reduce -

   a) magnetic leakage
   b) iron losses
   c) hysteresis losses
   d) the amount of wire

4. Silicon steel is used for the laminations in a transformer core because it -

   a) has a high resistance
   b) reduces noise
   c) has a high permeability
   d) has a low resistance

5. Silicon steel is used for transformer cores because it -

   a) reduces hysteresis loss
   b) keeps the iron loss to a minimum
   c) is cheaper than ordinary steel
   d) has low resistance

6. The component of no-load current which lags the transformer primary voltage by 90º is the -

a) magnetising current
b) iron loss current
c) secondary current
d) primary current

7. The material most commonly used for transformer windings is -

a) aluminium
b) copper
c) silicon steel
d) iron

8. Transformer laminations are prevented from shorting together by -

a) a varnish or oxide layer on each lamination
b) a layer of insulation between each lamination
c) filling the transformer with insulating oil
d) using spacing blocks to provide air gaps

9. The approximate phase angle of a transformer operating on no-load is -

a) 0º
b) 15º
c) 85º
d) 180º

10. The no-load current of a transformer is equal to the -

a) magnetising current only
b) iron loss current only
c) phasor difference of the magnetising and iron loss currents
d) phasor sum of the magnetising and iron loss current

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

1. In practice the_____(1)_____load current of a transformer is constant.
2. If the two windings of a transformer are wound, one on top of the other, thewinding is known a___(2)_____type winding.
3. A single phase transformer which has its windings on the centre limb of thelaminations is called a_______(3)_____type transformer.
4. Eddy currents in a transformer are caused by___(4)_____in the iron core.
5. In an unloaded transformer, the magnetising current___(5)_____the primaryvoltage by approximately______(6)____________degrees.
6. Joints in the laminations of a transformer core are staggered so as to minimise _____(7)_____.
7. The iron core of a core type transformer is constructed using laminations cut to aparticular shape, and are called____(8)_______and____(9) laminations.
8. In smaller transformers the lamination joints may be butted together, whereas in largepower transformers the joints are________(10)__.
9. Laminations used in the construction of a transformer core are approximately _____(11)_____thick.
10. If a transformer was constructed using a solid iron core the___(12)_____loss would be very large and the transformer would run very hot.
11. Flux established by the primary that does not cut the conductors of the secondary isknown as___(13)___flux.
12. The secondary voltage of a transformer is____(14)_____degrees out of phase withthe primary voltage.
13. The only factor that is common to both the primary and secondary windings of atransformer is the core_(15)_____.
14. If a transformer was constructed using a mild steel core the__(16)_____loss would be very large and the transformer would run very hot.

SECTION C

1. What is meant by the term *leakage flux*, and how is it kept to a minimum?
2. A 240/115V single phase transformer has 960 turns on its primary winding. Calculatethe number of turns required on the secondary winding. (460 turns)
3. A 240/12V downlight transformer draws a no-load current of 0.6A at a phase angle of80º lag. Using a scale of 1mm = 10mA, draw the no-load phasor diagram for the transformer and from the diagram determine the -

   a) magnetising current (0.59A)

   b) iron loss current. (0.104A)

4. 4.A single phase 240/415V transformer has a no-load primary current of 0.8A andtakes 78W from the supply. Determine the -

   a) no-load power factor (0.406 lag)

   b) no-load phase angle (66º lag)

   c) magnetising current (0.73A)

   d) iron loss current. (0.325A)

   For parts (c) and (d) use a scale: 1mm = 0.01A

5. A single phase transformer steps down from 415V to 32V. Calculate the primarycurrent if the secondary current is 5A. (0.386A)
6. A transformer is wound with 250 turns on the primary and 50 turns on the secondary.The maximum core flux is 0.04Wb and the supply frequency 50Hz. Determine the -

   a) primary voltage (2220V)

   b) secondary voltage (444V)

   c) transformation ratio (5:1)

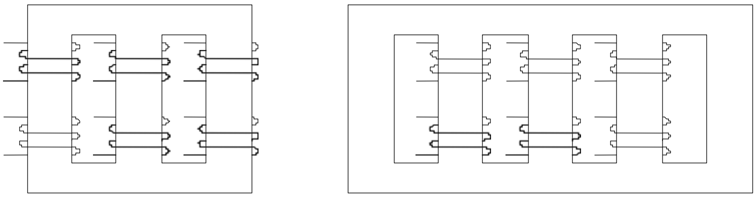
7. A 250/500V transformer has a magnetising current of 4.92A and an iron loss currentof 0.88A. Determine the no-load primary current and phase angle. (5A, 79.8º lag)

   Scale: 1mm = 0.1A

8. A 300/32V, 50Hz single phase transformer has 500 primary turns. Determine themaximum value of core flux. (0.0027Wb)

SECTION D

1. Identify the two types of transformer core shown in figure 1.



(a) (b)

Figure 1

2. Sketch the winding arrangements for concentric, sandwich and side by side windings.
3. Explain why a stepped core would be used in a large power transformer.
4. List applications for core and shell type transformers.
5. Why are transformer laminations clamped tightly together?

Tutorial 3 **NAME:**

TRANSFORMER OPERATION

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The primary and secondary voltages of a transformer are -

a) in phase
b) 90º out of phase
c) 120º out of phase
d) 180º out of phase

2. In a transformer the component of no-load current which lags the primary voltageby 90º is the -

a) magnetising current
b) iron loss current
c) secondary current
d) primary current

3. In general the power factor of the primary side of a transformer with an inductivesecondary load is -

a) lower than
b) equal to
c) higher than
d) unrelated to the power factor of the secondary winding.

4. The primary and secondary currents of a transformer are "**approximately**" -

a) in phase
b) 60º out of phase
c) 90º out of phase
d) 180º out of phase

5. The no-load power factor of a transformer is

approximately -a) 0.1
b) 1.0
c) 0.9
d) 0.707

6. Transformers are rated in terms of the -

a) true power out
b) true power in
c) apparent power out
d) apparent power in

7. In order to obtain maximum cooling effect a transformer tank should be -

a) plain
b) finned
c) tubed
d) painted in a light colour

8. An oil filled transformer which is cooled by means of a fan blowing across theradiators on the tank is termed -

a) ONAN
b) OFAF
c) OFAN
d) ONAF

9. Transformer oil is used to -

a) aid cooling of the transformer
b) enhance the level of insulation
c) keep the windings free of moisture
d) aid cooling and enhance the level of insulation

10. As the load on the secondary of a transformer increases -

a) secondary current increases and primary current decreases
b) secondary current decreases and primary current decreases
c) secondary current increases and primary current increases
d) secondary current decreases and primary current increases

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The power factor of the primary of a lightly loaded transformer is generally ______(1)______than the power factor of the secondary load because of the effect of the ______(2)______current.

Transformers are usually rated in______(3)______.

The main function of oil in a transformer is to______(4)______the transformer.

The cooling mediums used in transformers are designated with the letters A, O and W. The letter A stands for______(5)_____, the letter O______(6)_____and the letter W _____(7)_____.

Cooling methods used in conjunction with transformers are designated by the letters N and F. The letter N stands for______(8)_____and the letter F______(9)_____.

The rating of a transformer is determined by its ability to dissipate heat under _____(10)_____load conditions.

The primary current of a transformer is made up of two main components, the no-load current and the______(11)_____component of primary current.

A transformer that is cooled using only the surrounding air and oil in and around the windings, would be classified as______(12)_____.

The load component of primary current is determined using the secondary current and the______(13)_____ratio or the______(14)_____ratio.

The primary current of a transformer is equal to the______(15)_____sum of the no-load current and the load component of primary current.

If a 100kVA transformer is required to deliver 110kVA for an extended period, it is most likely that the transformer windings would______(16)_____.

SECTION C

1. Question 14.15, page 355, Electrical Principles for the Electrical Trades.(N_1 = 1833.3 turns, N_2 = 41.67 turns, I_1 = 5.25A, I_2 = 230.94A)
2. A single phase 240/32V transformer is to supply a low voltage lighting circuit. Theno-load current of the transformer is 2A at a power factor of 0.1 lag. If the lights takes a current of 40A at unity power factor, determine the -
   a) primary current (5.9A)
   b) primary phase angle (20° lag)
   c) primary power factor. (0.94 lag)Scale: 1mm = 0.1A
3. A 33/11kV, 20MVA transformer is used in a zone substation. Neglecting any lossesdetermine the -
   a) full load secondary line current (1049.7A)
   b) full load primary line current (349.9A)

4. A 240/12V downlight transformer has a rating of 100VA. Determine the -
    a) full load secondary current (8.33A)
    b) number of 50W lamps that may be supplied from the transformer. (2)

5. A 240/110V single phase transformer takes a no-load current of 2.5A at a power factor of 0.1 lag. If the transformer supplies a load current of 20A at a power factorof 0.866 lag, determine the -
    a) load component of primary current (9.17A)
    b) primary current (10.82A)
    c) primary phase angle (41º) Phasor diagram scale; 1mm = 0.1A
    d) primary power factor (0.75 lag)

SECTION D

1. What methods of cooling are used on the transformer shown in figure 1?

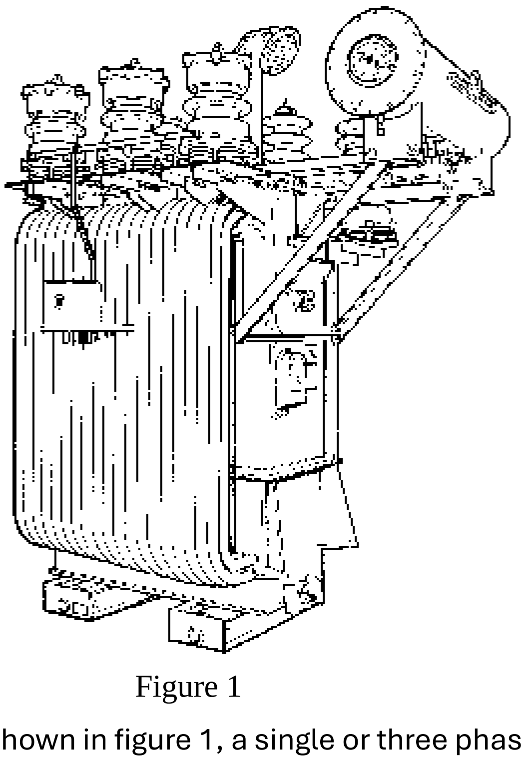


Figure 1

2. Is the transformer shown in figure 1, a single or three phase transformer?

Tutorial 4 **NAME:**

TRANSFORMER IMPEDANCE,

REGULATION AND EFFICIENCY

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The efficiency of a transformer -

a) is constant over the load range
b) has a maximum of 90%
c) varies with load
d) varies with the iron losses

2. The impedance of a transformer -

a) causes secondary voltage to drop when load current increases
b) limits fault current when secondary is short circuited
c) is determined by the core material and winding resistance
d) all of the above

3. The iron loss of a transformer at rated voltage and frequency is -

a) proportional to the load current
b) proportional to the square of the load current
c) practically constant at all times
d) dependent on the power factor of the load

4. The voltage drop within a transformer can be allowed for by-

a) using a tap changer to boost the secondary voltage
b) increasing the primary voltage
c) reducing the coupling between windings
d) increasing the turns on the primary

5. The iron loss of a transformer can be determined by measuring the power taken bythe transformer when -

a) the secondary is short circuited
b) normal load is applied to the secondary circuit
c) the secondary is open circuit and half normal voltage is applied to the primarywinding
d) the secondary is open circuit and normal voltage is applied to the primary winding

6. If the load on a transformer is doubled the iron losses are -

a) doubled
b) halved
c) constant
d) decrease slightly

7. The short circuit test on a transformer is used to determine -

a) ohmic impedance
b) percentage impedance
c) copper losses
d) all of the above

8. A single phase transformer is rated at 20kVA at 100V. The true power output atfull-load and 0.8 power factor is -

a) 25kW
b) 20kW
c) 16kW
d) 8kW

9. The all day efficiency of a transformer is the ratio of the -

a) input energy over 24 hours to the output energy over 24 hours
b) output kVA over 24 hours to the input kVA over 24 hours
c) input kVA over 24 hours to the output kVA over 24 hours
d) output energy over 24 hours to the input energy over 24 hours

10. If a transformer operates for long periods during a day with no-load, the all dayefficiency of the transformer is -

a) high
b) very low
c) not affected by no-load operation
d) reduced slightly

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

Transformers are rated in______(1)_____because this allows the power factor of the load to be ignored.

Maximum efficiency of a transformer occurs at the load which makes the _____(2)_____equal to the______(3)_____.

The short circuit test on a transformer is used to determine the______(4)_____losses.

The copper losses of a transformer are 400W at full-load. If the load is reduced to half load, the copper losses are______(5)_____watts.

Copper losses in a transformer vary as the______(6)_____of the current.

The______(7)_____losses in a transformer are constant for all loads at rated voltage and frequency.

When measuring the iron losses of a transformer, the secondary winding must be _____(8)_____.

The efficiency of a transformer is the ratio of the______(9)_____power to the _____(10)_____power.

Subtracting the output power from the input power gives the______(11)_____of a transformer.

To achieve the best all day efficiency, a transformer should be operated at or near _____(12)_____load for the entire day.

Voltage regulation of a transformer is voltage drop between no load and full load expressed as a_______(13)_____of no load volts.

Typical values of transformer efficiency fall within the range______(14)_____to _____(15)_____.

The voltage required to cause rated current to flow during a short circuit test expressed as a percentage of rated voltage is known as______(16)_____.

SECTION C

1. Calculate the efficiency of a 500kVA distribution transformer when operating atfull-load with a power factor of 0.9 lag. The total losses are 15kW. (96.8%)
2. A transformer when tested using the open circuit test had an iron loss of 3700W andwhen tested using the short circuit test had a copper loss of 2100W. Determine the total transformer loss. (5800W)
3. A 10MVA transformer operates with a power factor of 0.85. The transformer ironlosses are 120kW and the copper losses 95kW. Calculate the efficiency of the transformer. (97.5%)
4. A 33kV/11kV, three phase transformer with a rating of 500kVA has a voltage regulation of 6% at a power factor of 0.8. Determine the secondary line and phase voltage of the transformer at full load 0.8 power factor if the no load line voltage is11kV. (V_L=10340V, V_P= 5970V)
5. A 33kV/11kV, three phase transformer with a rating of 500kVA has a percentage impedance of 4.5%. Determine the secondary prospective short circuit current of thetransformer. (583A)

6. Determine the full load efficiency of a transformer supplying full load output of 15kW at unity power factor, if the transformer has iron losses of 400W and copperlosses of 800W when tested at full load. (92.6%)

7. A 50kVA transformer has a full load copper loss of 460W and an iron loss of220W. Determine the -

a) iron loss when delivering 25kVA (220W)

b) copper loss when delivering 25kVA. (115W)

8. Calculate the all day efficiency for a 750kVA, 11kV/415V distribution transformerthat operates with the following energy levels and times -

8 hours delivering 800kW with an input of 810kW
2 hours on no-load, taking 20kW
6 hours delivering 350kW with an input of 370kW
8 hours delivering 600kW with an input of 615kW. (97.36%)

SECTION D

1. Re-draw the components in figure 1 to show the connections required to carry outa short circuit test on the transformer.

SECTION D

1. Re-draw the components in figure 1 to show the connections required to carry out a short circuit test on the transformer.

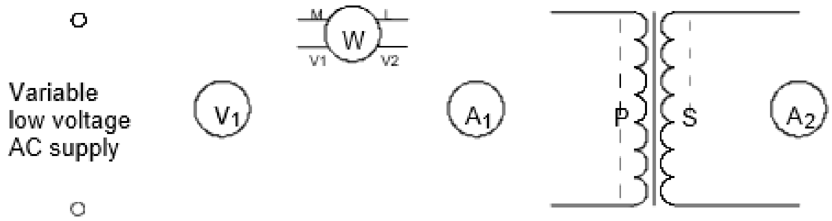


Figure 1

2. Re-draw the components in figure 2 to show the connections required to carry out an open circuit test on the transformer.

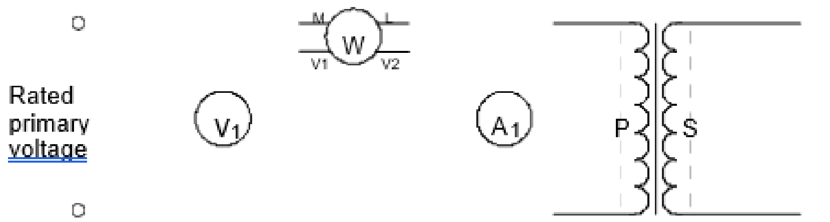


Figure 2

2. Draw a set of axis showing percentage efficiency versus load for a transformer. Onyour axis show the characteristics for efficiency, copper loss and iron loss. Also show the condition required for maximum efficiency.

Tutorial 5 **NAME:**

TRANSFORMER POLARITY & PARALLELING

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. Transformers are paralleled when -
   a) a greater output voltage is required
   b) the load becomes too large for one transformer
   c) transformer regulation must be minimised
   d) the effect of the vector groups must be reduced
2. A transformer designated Dy11 would have a -
   a) star primary, delta secondary and 0º phase shift
   b) star primary, delta secondary and 30º phase shift
   c) delta primary, star secondary and 30º phase shift
   d) delta primary, delta secondary and 0º phase shift
3. Load sharing by parallel transformers of equal rating is dependent upon therespective transformer -
   a) line voltage
   b) vector group
   c) impedance
   d) voltage regulation
4. When conducting a final additive/subtractive polarity test for paralleling two singlephase transformers, the voltmeter is connected across -
   a) each transformer primary winding
   b) each transformer secondary winding
   c) the two transformer secondaries in series
   d) the two transformer primaries in parallel
5. Which of the following combinations of three phase transformers may be paralleled
   a) star/star and star/delta
   b) delta/star and star/star
   c) delta/delta and star/delta
   d) delta/star and star/delta

6. As long as certain other characteristics are identical, a 3-phase star/delta transformercan be connected in parallel with a second transformer which has its primary delta connected and its secondary connected in -
   a) delta
   b) star
   c) inter-star
   d) zig-zag

7. Three phase transformers that are to be paralleled -
   a) must come from an alternate vector group
   b) can come from any vector group
   c) are not affected by their vector group
   d) must come from the same vector group

8. Transformer polarity marks indicate the direction of current -
   a) into the primary and out of the secondary
   b) out of the primary and into the secondary
   c) into the primary and into the secondary
   d) out of the primary and out of the secondaryat the same instant

9. When the primary and secondary terminal voltages are in the same direction atevery instant, the transformer is said to have -
   a) additive polarity
   b) negative polarity
   c) subtractive polarity
   d) positive polarity

10. Which of the following combinations of three phase transformers may be paralleled
   a) Dy1 and Dy11
   b) Dy11 and Yd1
   c) Yy0 and Dd6
   d) Dy1 and Yd1

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

When two transformers of equal rating are paralleled, the transformer with the _____(1)_____impedance will take the greater share of load.

If two transformers of equal rating and impedance are paralleled, the transformers will share the load______(2)_____.

Transformers are connected in parallel to provide additional______(3)_____.

Transformers are paralleled when the load becomes______(4)_____for one transformer.

Identical single phase transformers that are to be paralleled must have the same _____(5)_____,______(6)_____and______(7)_____.

The two methods used to mark the polarity of the terminals of a transformer are _____(8)_____and_______(9)_____.

When the primary and secondary terminal voltages of a transformer are in the same direction at every instant, the transformer is said to have______(10)_____polarity.

When the primary and secondary terminal voltages of a transformer are in opposite directions at every instant, the transformer is said to have______(11)_____polarity.

Three phase transformers that are to be paralleled must have identical______(12)_____, _____(13)_____,______(14)_____,______(15)_____and______(16)_____.

SECTION C

1. Three single phase 5:1 transformers have their primaries connected in star to a415V supply. The delta connected secondaries supply three 6Ω star connectedelements. Determine -

   a) primary phase voltage (240V)
   b) secondary phase and line voltages (48V, 48V)
   c) load phase current (4.62A)
   d) secondary line current (4.62A)
   e) secondary phase current (2.67A)
   f) primary phase and line current. (0.53A, 0.53A)

2. A three phase 415V inductive load is to be supplied by a three phase delta/star stepdown transformer. If the primary line voltage is 1000V, determine the required transformer ratio. (4.17:1)

3. A three phase 11kV/415V star-star transformer supplies a load consisting of three delta connected heating elements. If the secondary line current is 173A determinethe -

   a) transformation ratio (26.46:1)
   b) load phase current (100A)
   c) load phase voltage (415V)
   d) resistance of each heating element (4.15Ω)

e) transformer primary line current. (6.54A)

4. Two transformers of equal rating are to be paralleled to supply a load of 3MVA. If transformer A has an impedance of 5% and transformer B an impedance of 4.5%, determine how the transformers will share the load. (Tx A = 1.42MVA and Tx B = 1.58MVA)

5. Two 33kV/5kV, 15MVA transformers are to be paralleled. Show by calculation ifthey will operate satisfactorily to supply a 25MVA load. The transformer impedances are $\%Z_A$ = 6% and $\%Z_B$ = 3.5%. (Tx A = 9.2MVA and Tx B = 15.8MVA, not satisfactory Tx B overloaded)

SECTION D

1. What would be the expected voltmeter readings in the circuit of figure 1, if thetransformers were -

   a) correctly paralleled
   b) incorrectly paralleled.

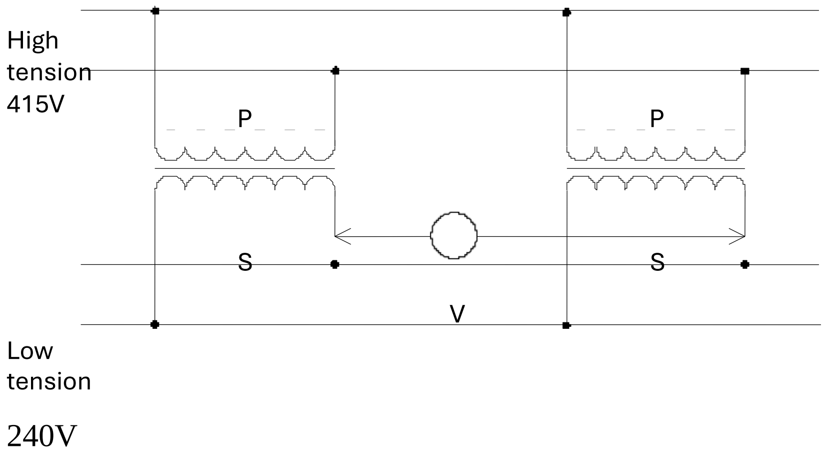


Figure 1

2. What would be the expected voltmeter readings in the circuit of figure 2, if thetransformers were -

   a) correctly paralleled
   b) incorrectly paralleled.

3.

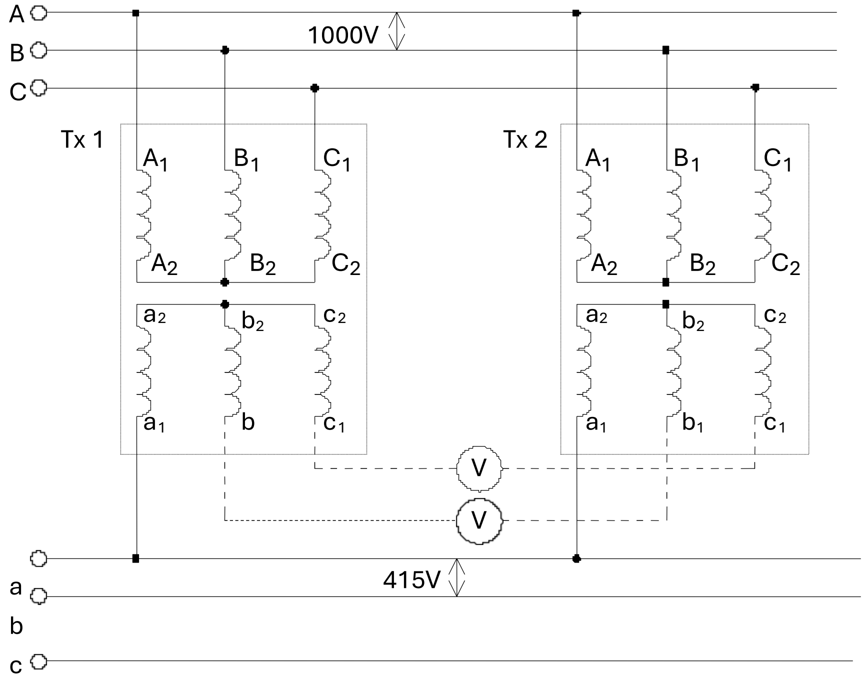


Figure 2

Tutorial 6 **NAME:**

INSTRUMENT & AUTO-TRANSFORMERS

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. In an auto transformer the current in the primary is 10 amperes and the current inthe secondary is 20 amperes; the current in the common part of the winding is—
   a) 30 amperes.
   b) 20 amperes.
   c) 15 amperes.
   d) 10 amperes.
2. The current in the common section of the winding of an auto transformer, when onload is equal to—
   a) the phasor sum
   b) the phasor difference
   c) the sum.
   d) the difference

   of the primary and secondary currents.
3. When an auto transformer is properly designed, one of the features compared to adouble wound transformer of the same rating is -
   a) larger physical size
   b) requires less material to manufacture
   c) has a lower efficiency
   d) has higher losses
4. The rated secondary current of a standard current transformer is -
   a) 0.6A
   b) 5A
   c) 10A
   d) 25A
5. The rated standard secondary voltage of a potential transformer is -
   a) 415V
   b) 240V
   c) 120V
   d) 110V

6. If the instrument is to be removed from the secondary of a current transformer it isnecessary to -
   a) short circuit the primary terminals
   b) short circuit the secondary terminals
   c) open circuit the secondary terminals
   d) open circuit the primary terminals

7. A certain current transformer when operating at full rated current has a primarycurrent of 550A, the secondary current would be -
   a) 110A
   b) 10A
   c) 5A
   d) unknown

8. An 11kV potential transformer has a primary voltage of 11kV applied, thesecondary voltage would be -
   a) 110V
   b) 5V
   c) 1V
   d) unknown

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

Instrument transformers are usually rated in terms of their______(1)_____output.

The secondary of a______(2)_____transformer must always be short circuited before disconnecting its associated meter.

The more common Australian standard secondary current of a current transformer is _____(3)_____amperes.

The primary circuit of instrument type______(4)_____transformers should always be protected by fuses.

When the primary of a current transformer is energised and the secondary is open circuited, a high______(5)_____is produced at the secondary terminals.

Auto transformers are transformers with a______(6)_____winding.

The current in the common part of an auto transformer is the______(7)_____of the primary and secondary currents.

In an auto transformer, the primary current is 5A and the secondary current is 12A. The current in that part of the winding which is common to the primary and secondary is _____(8)_____amperes.

The applications of auto transformers is limited due to the danger of a______(9)_____ between the primary and secondary.

The minimum acceptable insulation resistance for a transformer between windings is _____(10)_____and between windings and earth______(11)_____.

To provide additional protection, some transformers are fitted with an______(12)_____ shield between the primary and secondary windings.

Instrument transformers are of two types,______(13)_____transformers and _____(14)_____transformers.

A variac is an example of the use of an______(15)_____transformer.

The rated standard secondary voltage of a potential transformer is______(16)_____ volts.

SECTION C

1. An auto transformer is used to step down from 300 volts to 200 volts. The complete winding consists of 600 turns and the secondary current is 30 amperes.Determine:
   a) secondary turns (400 turns)
   b) primary current (20A)
   c) current in common portion of winding, neglect all losses (10A).
2. Determine the current at full load, in the common section of the winding of a singlephase 440/415V, 5kVA auto transformer. Neglect losses. (0.69A)
3. A 400/32V, 0.5kVA, single phase auto transformer delivers full load at unity power factor. Determine the current in the common section of the winding. Neglect losses.(14.375A)
4. An auto transformer is used to step up from 200 volts to 250 volts. The primary winding consists of 400 turns and the secondary current is 20 amperes. Determine:
   a) secondary turns (500 turns)
   b) primary current (25A)
   c) current in common portion of winding, neglecting all losses (5A).
5. A 500/5A CT has a primary current of 450A, what is the secondary current?(4.5A)
6. A 415/110V potential transformer has a primary applied voltage of 425V, what isthe secondary voltage? (112.65V)
7. A 1000/5A CT has a secondary current of 3.5A, what is the primary current?(700A)

8. A three phase, 11kV/415V, delta/star transformer supplies a star connected loadconsisting of three 15Ω heating elements. Determine -
   a) primary phase voltage (11kV)
   b) secondary phase and line voltages (240V, 415V)
   c) load phase voltage (240V)
   d) load phase current (16A)
   e) secondary line current (16A)
   f) secondary phase current (16A)
   g) transformation ratio (45.83:1)
   h) primary phase and line current. (0.349A, 0.605A)

9. A three phase 11kV/415V star-star transformer supplies a load consisting of three delta connected heating elements. If the secondary line current is 200A determinethe -
   a) transformation ratio (26.46:1)
   b) load phase current (115.47A)
   c) load phase voltage (415V)
   d) resistance of each heating element (3.59Ω)
   e) transformer primary line current. (7.56A)

10. Two transformers of equal rating are to be paralleled to supply a load of 2MVA. Iftransformer A has an impedance of 5% and transformer B an impedance of 4%, determine how the transformers will share the load. (Tx A = 0.889MVA and TxB = 1.111MVA)

SECTION D

1. Re-draw the symbols shown in figure 1 and connect the ammeter, voltmeter and wattmeter to measure the line current and line voltage of the three phase motor. The instruments are to be connected via instrument transformers. Note, a bar type CT is used.

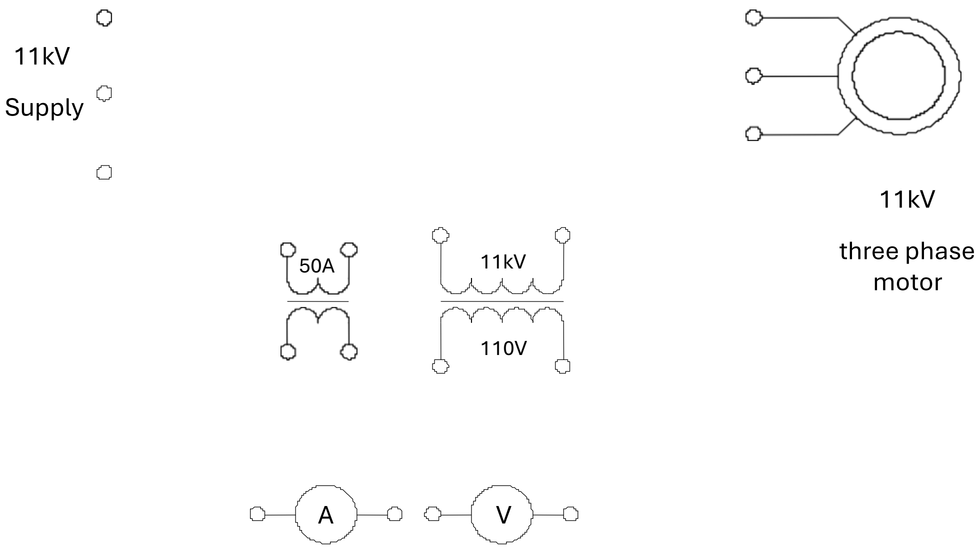


Figure 1

TUTORIAL - D.C. GENERATORS PART 1

NAME: ____

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. A DC generator converts_______energy to________energy.

    (a) electrical, mechanical

    (b) electrical, electrical

    (c) chemical, electrical

    (d) mechanical, electrical

2. The principle by which emf's are generated in a DC generator is:

    (a) electromagnetic induction.

    (b) Lenz's law .

    (c) self inductance.

    (d) chemical reaction.

3. The function of the commutator in a DC generator is to:

    (a) connect the AC generated in the windings directly to an external circuit.

    (b) convert the AC generated in the windings to DC when connecting to an external circuit.

    (c) supply an external current to the armature to drive the generator.

    (d) allow the generator to be converted to a motor.

4. The windings for the magnetic field system are mounted on the:

   (a) Armature.
   (b) Commutator.
   (c) Frame.
   (d) Pole cores.

5. The value of the generated emf's in the armature conductors is_______to the field flux, and_______to the armature speed.

   (a) Proportional, proportional
   (b) Proportional, inversely proportional
   (c) inversely Proportional, proportional
   (d) inversely Proportional, inversely proportional

6. To increase the output of a generator you could either_______the field current or _______ the armature speed.

   (a) decrease, decrease
   (b) increase, decrease
   (c) increase, increase
   (d) decrease, increase

7. The relationship between current, magnetic flux and the force applied to a conductor within a generator can be determined by:

   (a) Fleming's right hand rule.
   (b) Fleming's left hand rule.
   (c) Faraday's right hand rule.
   (d) Faraday's left hand rule.

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

8. The conductors for the field system of a generator are located in the_________.

9. To connect the generated emf's to an external circuit, a_________and carbon___-______are employed.

10. The function of the_________is to convert the_________voltage generated within the armature conductors to the D.C. voltage available at the generator terminals.

11. The generator field can be either_________excited or_________excited.

12. To determine the polarity of the induced emf's within the armature conductors you would use Flemming’s_________hand rule.

13. Maximum emf will be induced in the armature conductors when cutting the field flux at_________.

14. If more turns are added to the armature conductors, the generated voltage will______.

15. The emf induced into a conductor is proportional to the_________of the magnetic field, the_________of the conductor and the_________of the conductor through the magnetic field.

Section C:

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

16. A single conductor of 150mm length is rotated through a field flux of 0.8T at a velocity of 10m/s. Determine the emf induced in the conductor. (1.2V)

17. Determine the flux density of the magnetic field required to generate 12.6V in a conductor with an effective length of 2m which moves through the magnetic field at 90^0 with a uniform velocity of 10.5m/s. (0.6T)

18. A generator is wound with 6 series connected coils, each wound with 40 turns. If the length of the armature is 200mm, the density of the flux is 1.25 Tesla and the armature rotates with a velocity of 2m/s, determine the generated output voltage of the generator. (240V)

19. A separately excited generator has an effective field flux of 0.02T, and is spins at 400 rpm. If the machine constant is 12, determine the generated voltage. (96V)

20. For the diagram of figure 27, label the following:

    (a) the frame
    (b) the field coil
    (c) the armature
    (d) the field pole

Include the diagram with your answer sheet.

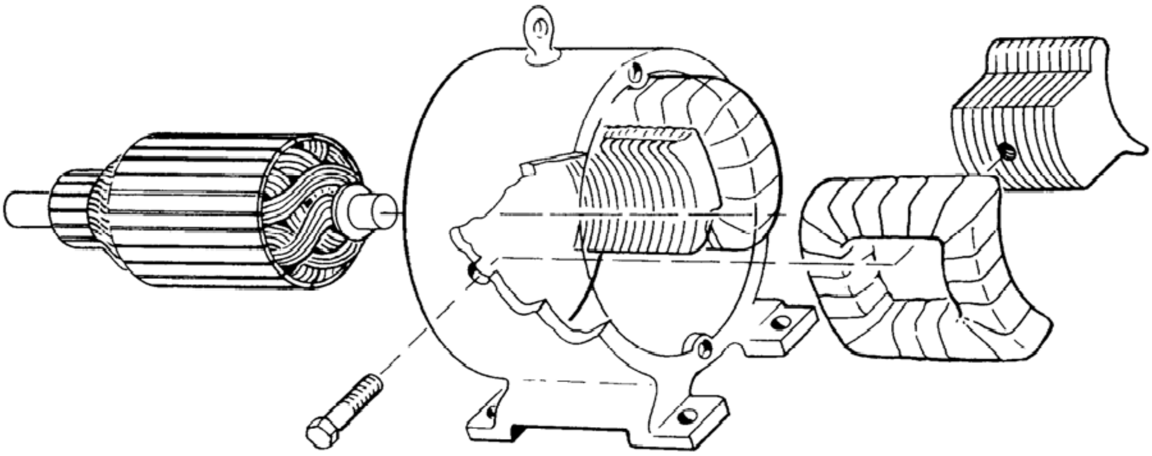


Figure 27.

TUTORIAL - DC GENERATORS PART 2

NAME:

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. If a generator is connected for a shunt configuration, the field connections would be a ______ resistance field connected in______with the armature.

   (a) High, series

   (b) High, parallel

   (c) Low, series

   (d) Low, parallel

2. A self-excited shunt generator relies on ______ ______ for its initial magnetic flux.

   (a) Separate excitation

   (b) Residual magnetism

   (c) Field flashing

   (d) Good luck

3. The generator type which is used for certain welding applications would be a _______ type.

   (a) Differentially compounded

   (b) cumulatively compounded

   (c) shunt

   (d) Series

Section B

For the following questions, complete the statements on your answer sheet with the word or phrase you think fits best.

4. When the field current in a separately excited generator is zero, the output voltage is not zero due to__________________.

5. If the speed of the prime mover driving a generator is reduced, the output voltage will ________________ .

6. Increasing the load on a generator causes the prime mover speed to __________________ due to the_________________developed by the armature current.

7. As the load on a generator increases, the terminal voltage___________________. This is due to________________and the__________________voltage drop.

8. The terminal voltage of a generator is the__________________between the generated voltage and the__________________voltage drop.

9. The open circuit characteristic of a separately excited generator shows the __________________ of the magnetic material used in core.

10. For a self-excited generator to build up a generated emf, there must be __________________ in the magnetic circuits of the machine.

11. Three types of self-excited generators are__________________connected, ________________ connected and_________________connected.

12. A shunt connected generator will have a_________________terminal voltage at full load than at no load. This is due to the_________________effect of _________________ and the_______________in the armature circuit.

13. If the speed of the prime mover driving a self-excited generator is_______________, then the small emf generated by____________________will not increase sufficiently to build up the required magnetic flux.

Section C:

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

14. A separately excited generator has an effective flux of 8mWb and is operated at a speed of 292 rpm. If the machine constant is 12, determine the:
    (a) generated voltage; (28V)
    (b) no-load terminal voltage. (28V)

15. Determine the field flux required to produce a no-load voltage of 240V in a separately excited generator rotating at 600rpm with a machine constant of 15. (26.7mWb)

16. Determine the speed a prime mover must drive a generator under no load to produce a terminal voltage of 300V. The generator has an effective flux of 20mWb and a machine constant of 15. (1000rpm)

17. A generator has an armature resistance of 0.15Ω and a full load resistance of 25Ω. If the open circuit voltage is 250V, determine the terminal voltage at full load. (248.5V)

18. A separately excited generator has an effective field flux of 0.02Wb, a machine constant of 12 and spins at 400 rpm. If the generator has an armature circuit resistance of 0.15Ω and an armature current of 20A, determine the load voltage for this condition. (93V)

19. The generator shown in figure 36 has a machine constant of 10, and effective flux of 25mWb and is driven at 1000rpm. Determine the:
    (a) Field current; (111 mA)
    (b) Generated voltage; (250V)
    (c) Armature current; (16. 54A)
    (d) Terminal voltage (248V)
    (e) Armature circuit voltage drop. (2V)

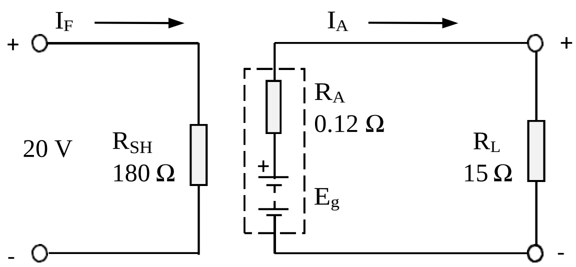


Figure 36.

TUTORIAL - D.C MOTORS PART 1

NAME: ____

Please note the following requirements in relation to tutorial work -

- All tutorial work is to be completed on ruled A4 pad paper, with multiple pages stapled together. Write on one side only of the answer sheets.
- All work is to be completed in ink.
- In the case of multiple choice type questions, the question number and answer letter are to be written on the answer sheet.
- All relevant equations and working are to be shown in the case of calculation type questions.
- All diagrams are to be drawn using appropriate drawing instruments. Drawings are not to be freehand.

Section A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. A DC motor converts_______energy to________energy.

   (a) electrical, mechanical
   (b) electrical, electrical
   (c) chemical, electrical
   (d) mechanical, electrical

2. To determine the forces acting on a current carrying conductor within a magnetic field, you would use:

   (a) Flemming's right hand
   (b) Lenz's law
   (c) right hand conductor rule
   (d) Flemming's left hand rule

3. The torque produced in a DC motor is _____ to the armature current and_______to the main field flux.

   (a) Inversely Proportional, proportional
   (b) Proportional, proportional
   (c) Inversely Proportional, Inversely proportional
   (d) Proportional, Inversely proportional

4. An increase in the load applied to a DC motor will cause the motor speed to ______ and the motor torque to_______.

   (a) Increase, increase
   (b) Decrease, decrease
   (c) decrease, increase
   (d) Increase, decrease

5. Whilst driving a load, a_______is generated in the armature conductors which ______ the applied motor voltage.

   (a) Counter emf, opposes
   (b) Counter emf, increases
   (c) Mutual emf, opposes
   (d) Mutual emf, increases

Section B:

Blank spaces in the following statements represent omissions. Write the appropriate information.

6. The force acting upon a current carrying conductor depends on the_________of the magnetic field, the_________flowing in the conductor and the__________of the conductor within the magnetic field.

7. The torque developed within a DC motor is proportional to the_________acting on the conductor and the_________of the armature.

8. If the load applied to a DC motor is decreased, the:

   (a) speed will_________,
   (b) the back emf will_________,
   (c) the armature current will_________and
   (d) the torque developed by the motor will_________.

9. The emf generated within the armature conductors_________the applied voltage, and is known as a_________.

10. The field system of a DC motor is mounted on the_________and the current in the armature conductors is transferred from the supply via the_________and_________.

11. The current flowing in the armature conductors is dependent on the _________ generated within the armature conductors.

12. If the load applied to a DC motor is increased, the:

(a) speed will_________,

(b) the back emf will_________,

(c) the armature current will_________and

(d) the torque developed by the motor will_________.

13. Motor torque is produced when the main_________reacts with the armature ________ .

Section C:

The following problems are to be solved with the aid of a calculator. Any working for a problem is to be fully shown. Where a problem involves calculating for circuit conditions, a neat and fully labelled circuit diagram (if not provided) is to accompany the question. Answers are to be expressed in the appropriate multiple or sub-multiple.

14. A 150mm long conductor carries a current of 40A at right angles to a magnetic field with a flux density of 0.5T. Determine the force acting on the conductor. (3N)

15. Determine the increase in flux density required in question 1 to increase the force acting on the conductor to 7N. (0.667T)

16. An armature has a radius of 125mm, and an effective conductor length of 150mm under the field pole. If the main flux is 0.4T and the armature current is 100A, determine

(a) the force acting on the conductor; (6N) and

(b) the torque developed on the conductor under the field poles. (0.75Nm)

17. An armature with a radius of 125mm is wound with 4 coils each of 100 turns. If the effective length of one half of a loop under the field poles is 200mm, the current in the conductors is 250A and the flux is 0.2T, determine the torque developed within the armature. (1000Nm)

18. A DC motor has a machine constant of 20, a main flux of 0.015Wb and runs at 750rpm. Determine the emf generated within the armature conductors. (225V)

19. If the motor in question 18 is connected to a 250V supply and has an armature circuit resistance of 0.15Ω, determine the amount of current flowing in the armature (167A)

20. The motor shown in figure 12 has a field flux of 0.0125Wb, runs at 250rpm, and hasa machine constant of 8. For these conditions, determine the:

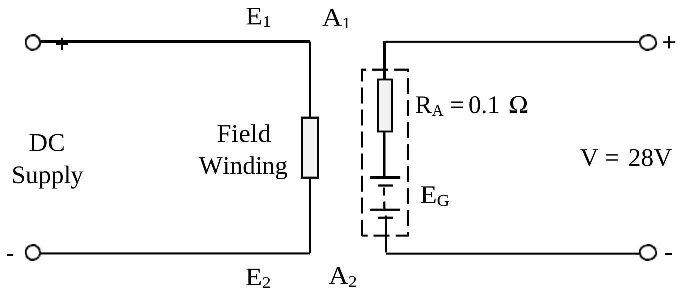


Figure 12.

(a) Back emf; (25V)

(b) Armature current; (30A)

(c) developed torque; (3Nm)

(d) armature circuit voltage drop. (3V)

****

Squirrel Cage Induction Motors

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The rotor current in a three phase induction motor is:-
   a) zero, since no supply is connected to the rotor circuit;
   b) supplied by the d.c. connected to the rotor terminals;
   c) supplied by the a.c. connected to the rotor terminals;
   d) induced by the stator field cutting the rotor conductors.

2. A three phase winding will produce an electromagnetic field which:-
   a) rotates at a constant speed;
   b) reverses direction each cycle;
   c) reverses direction each half cycle;
   d) is stationary and constant in strength.

3. Increasing the frequency of supply to a three phase stator winding will:-
   a) cause the magnetic field to rotate faster;
   b) cause the magnetic field to rotate slower;
   c) increase the strength of the magnetic field;
   d) increase the number of poles in the stator winding.

4. To reverse the direction of rotation of a rotating magnetic field you must:-
   a) reverse the connections to alternate pole windings;
   b) reverse the phase sequence of the supply;
   c) reverse the connections to the rotor winding;
   d) reverse the connections to all pole windings.

5. The rotor current in an induction motor is:-
   a) supplied from the separate rotor supply;
   b) induced by the rotating magnetic field;
   c) supplied from the stator supply terminals;
   d) always the same frequency as the stator supply.

6. The rotor speed of an induction motor is:-
   a) always slightly higher than the speed of the rotating magnetic field;
   b) always slightly lower than the speed of the rotating magnetic field;
   c) always the same as the speed of the rotating magnetic field;
   d) dependant only on the size of the load the motor is driving.

7. A six pole three phase motor on a 50 hertz supply will have a rated speed of about:-
   a) 2,800 r.p.m.;
   b) 1440 r.p.m.;
   c) 960 r.p.m.;
   d) 720 r.p.m.

8. The motor in question 7 will have a slip speed of:-
   a) 200 r.p.m.;
   b) 60 r.p.m.;
   c) 40 r.p.m.;
   a) 30 r.p.m.

9. When a three phase motor is running on no load and one supply conductor is open circuited:-
   a) the motor will stop and then start in the opposite direction;
   b) the motor will continue to run in the same direction;
   c) the motor will overload and burn out;
   d) the motor will stop due to loss of the RMF.

10. When a three phase motor is started with one supply conductor open circuited it will:-
    a) start and run normally;
    b) not start and may burn out;
    c) not start, but not burn out;
    d) start, but the direction of rotation will be random.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

As load on an induction motor increases the speed of the motor will______(1)_____ and the slip speed of the motor will______(2)_____.

The speed of the rotating magnetic field in a three phase induction motor depends on the number of poles in the winding and the______(3)_____.

The strength of the rotating magnetic field in a three phase induction motor is equal to _____(4)_____times the______(5)_____flux produce in one of the phase windings.

The direction that a three phase induction motor rotates depends on the______(6)_____ of the supply currents.

When an induction motor is driving a load the speed of the motor cannot reach_____(7)_____.

If the windings in a three phase induction motor are connected in delta the current in the conductors supplying the motor would be______(8)_____the current in the motor windings.

The stator core of a three phase induction motor is laminated to reduce______(9)_____ loss and the laminations are made from silicon steel to reduce______(10)_____loss.

The stator winding of a three phase induction motor consists of______(11)_____ identical winding displaced by_____(12)_____degrees from each other.

The______(13)_____induction motor has a short circuited rotor winding.

To change the direction of a three phase induction motor the connections to any two of the______(14)_____must be changed.

Either the rotor slots or the stator slots are______(15)_____to reduce the noise from a three phase induction motor.

When running on no load the speed of a three phase induction motor is _____(16)_____synchronous speed.

SECTION C

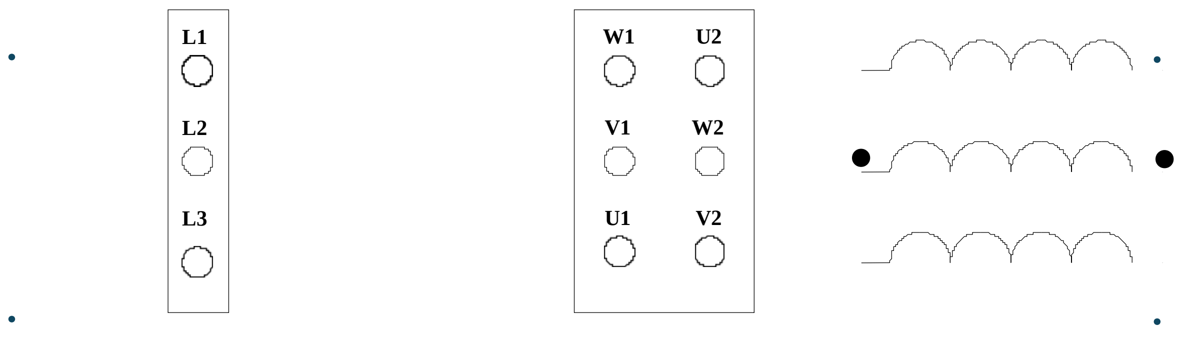
1. A six pole three phase induction motor is connected to a 60Hz supply and runs at full load at 1050r.p.m. Determine:-

a) the synchronous speed of the motor; (1 200 r.p.m.)

b) the slip speed of the motor. (150 r.p.m.)

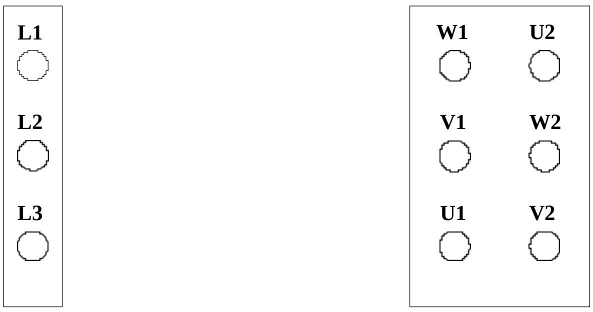
SECTION D

1. Figure 1 represents the stator windings of a three phase induction motor and it's terminal block:-
   a) Connect the windings to the terminal block using the international standard;
   b) Connect the terminals of the terminal block so that the motor windings are connected in delta;
   c) Connect the terminal block to the supply terminals.
   d) Connect the terminal block of Figure 2 to the supply terminals so that the direction of rotation of the motor in Figure 1 is reversed.



Supply Terminal Block Windings

<u>Figure 1.</u>



Supply Terminal Block

<u>Figure 2.</u>

SLIP-RING INDUCTION MOTORS

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. An advantage of wound rotor induction motors is:-
   a) high starting current and torque;
   b) low starting torque with low current;
   c) low starting current and high starting torque;
   d) high starting current and low starting torque.

2. The rotor and stator windings of a slip ring induction motor must have the same:-
   a) number of phases;
   b) number of poles;
   c) number of poles and phases;
   d) connection method (star or delta).

3. The rotor windings of a slip ring induction motor are connected to an external:-
   a) source of a.c. supply;
   b) source of d.c. supply;
   c) variable resistance;
   d) star delta starter.

4. The rotor and stator windings of a slip ring induction motor are normally connected:-
   a) rotor in star and stator in delta;
   b) rotor in delta and stator in delta;
   c) rotor in star and stator in star;
   d) rotor in delta and stator in star.

5. The rotor current in a slip ring induction motor:-
   a) is constant at all loads;
   b) increases as load increases;
   c) decreases as load increases;
   d) varies independent of load.

6. Resistance is added to the rotor circuit of a slip induction motor to:-
    a) increase torque at lower speeds;
    b) reduce current during starting;
    c) reduce the speed of the motor;
    d) all of the above.
7. An eight pole, 50 hertz slip ring induction motor running at 720r.p.m. with the slip rings short circuited has a slip percent of:-
    a) 60%;
    b) 15%;
    c) 6%;
    d) 4%.
8. The motor in question 7 will have a slip speed of:-
    a) 780 r.p.m.;
    b) 280 r.p.m.;
    c) 60 r.p.m.;
    d) 30 r.p.m.
9. A squirrel cage induction motor with a high resistance rotor, compared to one with a lower resistance, would have:-
    a) a lower full load slip and greater starting torque;
    b) a higher full load slip and greater starting torque;
    c) a lower full load slip and smaller starting torque;
    d) a higher full load slip and smaller starting torque.
10. In a squirrel cage induction motor with dual cage rotor:-
    a) the inner cage has the higher resistance and carries the greater current at starting;
    b) the outer cage has the higher resistance and carries the greater current at starting;
    c) the inner cage has the higher resistance and carries the least current at starting;
    d) the outer cage has the higher resistance and carries the least current at starting.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The emf induced in the rotor winding of a slip ring induction motor is a maximum at _____(1)_____.

Adding resistance to the rotor circuit of the slip ring induction motor at starting _____(2)_____the starting current taken by the motor and_______(3)_____the available starting torque.

If two of the three leads connecting the slip rings of the slip ring induction motor to it's starting resistors are reversed the direction of rotation of the motor will be _____(4)_____.

The unit of torque is the______(5)_____.

The direction that a three phase induction motor rotates depends on the______(6)_____ of the supply currents.

When the torque required by the load on an induction motor is increased the speed of the motor______(7)_____, the slip speed______(8)_____the voltage induced in the rotor conductors______(9)_____, which causes the current in the rotor conductors to _____(10)_____. This causes the strength of the rotor magnetic field to _____(11)_____, which causes the motor output torque to_______(12)_____to meet the increased load demand on the motor.

The______(13)_____induction motor has a wound rotor winding which is always _____(14)_____connected to allow the connection of_______(15)_____during starting to______(16)_____starting current and_______(17)_____starting torque.

SECTION C

1. A 4 pole three phase induction motor is connected to a 50Hz supply and runs at a full load slip of 4%. If the motor is delivering 33.16 newton metres of torque to the load at this speed with an efficiency of 83.3 percent and a power factor of 0.86 determine:-
   a) the synchronous speed of the motor; (1 500 r.p.m.)
   b) the slip speed of the motor; (60 r.p.m.)
   c) the rotor speed of the motor; (1440 r.p.m.)
   d) the output power of the motor; (5kW)
   e) the input power of the motor; (6kW)
   f) the line current from the 415 volt supply. (9.71A)

1. Figure 1 represents the incomplete circuit diagram of a three phase slip ring induction motor and it's supply:-
   a) Connect the stator windings in delta;
   b) Connect the rotor windings in star;
   c) Complete the required connections, including the supply and starting resistors, for the motor to start and run.

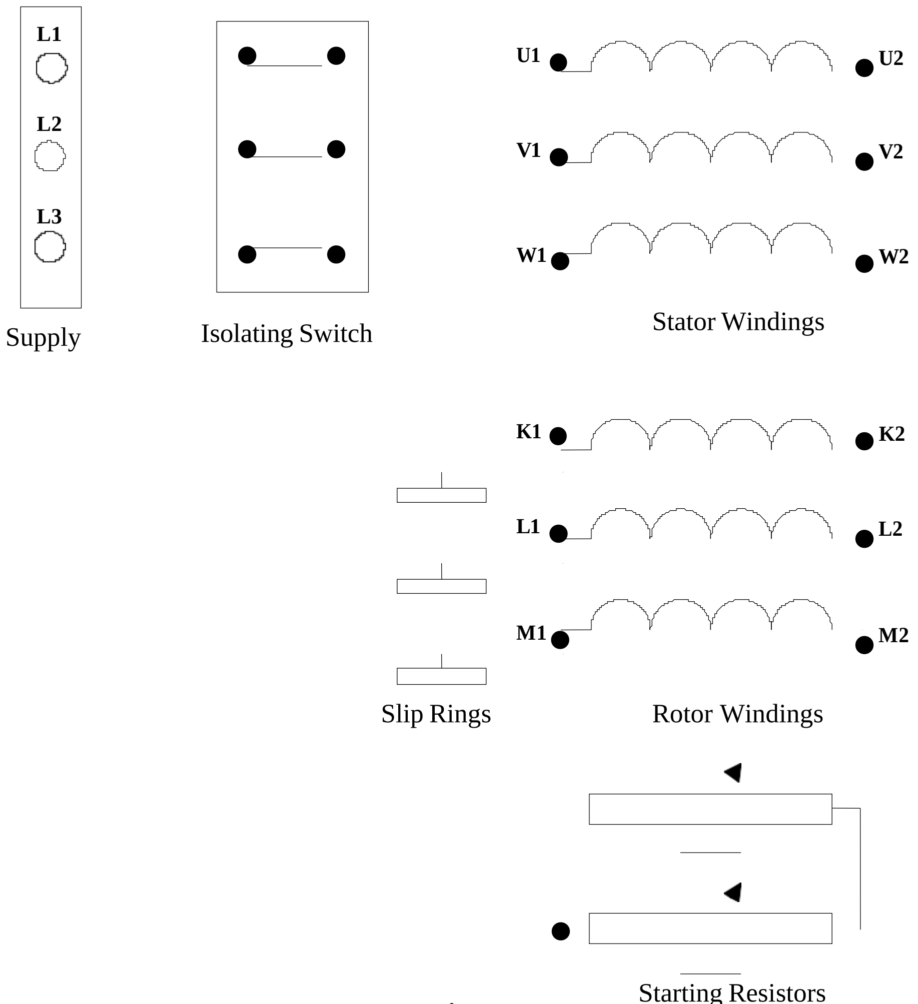


Figure 1.

Induction Motor Load

CHARACTERISTICS

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. Copper loss in an induction motor is due to:-

a) hysteresis in the stator and rotor cores;
b) eddy currents in the stator and rotor core;
c) resistance of the stator and rotor windings;
d) friction and windage loss in the motor.

2. The efficiency of an induction motor on no load is:-

a) 100 percent;
b) about 50 percent;
c) about 10 percent;
d) zero percent.

3. The mechanical losses on no load in an induction motor include:-

a) hysteresis in the stator and rotor cores;
b) eddy currents in the stator and rotor core;
c) resistance of the stator and rotor windings;
d) friction and windage loss in the motor.

4. The difference between the input power to a motor and the output power from a motor is the:-

a) total loss given off as heat;
b) electrical loss given off as resistance;
c) mechanical loss given off as friction;
d) magnetic loss given off as inductance.

5. An increase in rotor current in an induction motor:-

a) reduces stator current to keep stator flux constant;
b) reduces power factor due to rotor inductance;
c) reduces motor efficiency due to increased losses;
d) causes stator current to increase to maintain stator flux.

6. The no load current of an induction motor is shown on a phasor diagram as:-

a) the magnetising current and the iron loss current;
b) the rotor current and the stator current;
c) the copper loss current and the iron loss current;
d) the copper loss current and the magnetising current.

7. As the load on an induction motor increases:-

a) both the efficiency and the power factor improve;
b) efficiency increases but power factor decreases;
c) efficiency decreases and power factor decreases;
d) efficiency decreases but power factor increases.

8. The stator component of current due to rotor current is:-

a) equal to the rotor current and in phase with the rotor current;
b) dependant on the turns ratio and in phase with the rotor current;
c) equal to the rotor current and opposite in phase to the rotor current;
d) dependant on the turns ratio and opposite in phase to the rotor current.

9. Most induction motors are designed to have maximum efficiency:-

a) when rotor resistance equals rotor inductive reactance;
b) close to full load as most motors run at this load;
c) at starting to give increased starting torque;
d) at about half of full load as a compromise.

10. In a squirrel cage induction motor:-

a) iron losses vary as the square of the load while other losses are almost constant;
b) stator losses vary as the square of the load while other losses are almost constant;
c) rotor losses vary as the square of the load while other losses are almost constant;
d) copper losses vary as the square of the load while other losses are almost constant.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

Copper losses in a squirrel cage induction motor occur in______(1)______while hysteresis and eddy current losses occur in______(2)______. Mechanical losses occur due to______(3)______and______(4)______.

If voltage and frequency supplying an induction motor remain constant then the ______(5)______losses and______(6)_____losses remain relatively constant. The variable______(7)_____loss varies in proportion to the_______(8)_____.

Maximum efficiency occurs when the______(9)_____losses equal the _____(10)_____losses while maximum torque occurs when the_______(11)_____ equals the______(12)_____.

If a motor running on full load has some load removed the speed of the motor _____(13)_____slightly, causing a_______(14)_____in rotor voltage, a _____(15)_____in rotor current, a_______(16)_____in rotor flux and a _____(17)_____in torque. The motor will settle to a constant speed when _____(18)_____equals______(19)_____.

SECTION C

1. A 4 pole three phase 415 volt 50Hz squirrel cage induction motor runs at 1460 r.p.m. while delivering 9 kilowatts to its load at a maximum efficiency of 88 percent. If the power factor of the motor at this load is 0.86 lag determine:-
   a) the input power to the motor; (10 227W.)
   b) the line current taken by the motor; (16.55A.)
   c) the torque delivered to the load; (58.9Nm.)
   d) the losses in the motor; (1 228W.)
   e) the copper losses in the motor. (614W.)

2. A 415V squirrel cage induction motor delivers 116 Nm of torque when started on full voltage. The voltage to the motor must be reduced to 320 volts to limit starting current in line with supply authority requirements. Determine the starting torque at the reduced voltage. (69Nm.)

1. Figure 1 is a set of performance curves for a 5kW, 6 pole 415 volt squirrel cage induction motor. From the curves determine:-

   a) Line current, speed and efficiency at rated load;
   b) Input power, line current and power factor at no load;
   c) Speed and efficiency when stator current is 8 amperes.

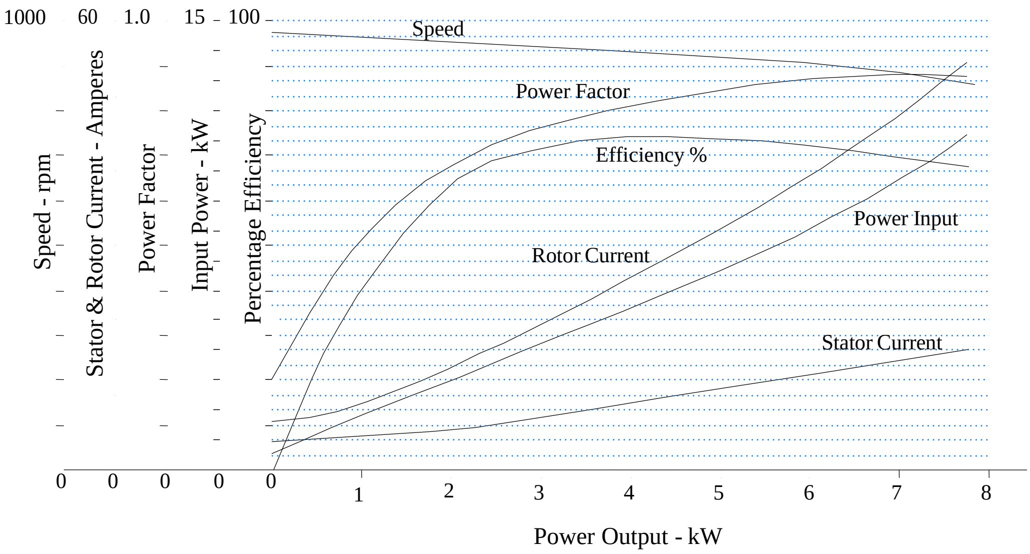
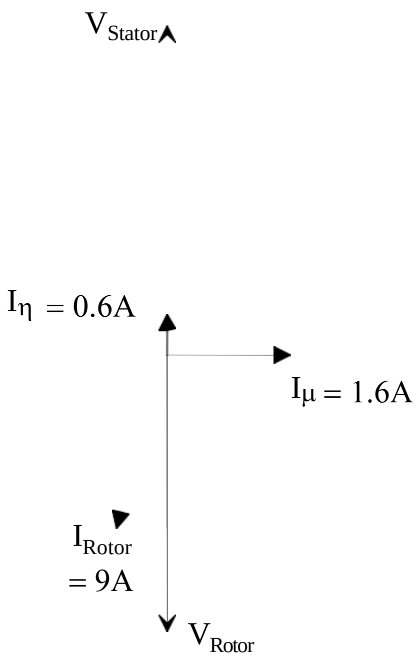


Figure 1

2. Figure 2 is a phasor diagram of a squirrel cage induction motor which shows three components of current in the motor. If the load component of stator current is one third of the rotor current complete the phasor diagram to determine:-

   a) the current scale for the stator currents; (10mm = 1A)
   b) the no load current and power factor; (1.7A @ 0.352lag)
   c) the load component of stator current; (3A @ 16.7^{O}lag)
   d) the total current taken from the supply at this load; (4.26A)
   e) the power factor of the motor at this load. (0.815lag)



Induction Motor Starting

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The overload device in a motor stater provides:-
   a) protection against short circuits inside the motor;
   b) overload protection for the motor and its supply conductors;
   c) short circuit protection for the motor supply conductors;
   d) all of the above.

2. Thermal overloads need to cool after tripping before they can be reset. This is:-
   a) a problem because the motor cannot be turned back on immediately;
   b) overcome by using magnetic overloads to allow faster reset times;
   c) to prevent the circuit breaker at the switchboard from tripping unnecessarily;
   d) to allow the motor windings to cool before being reconnected to the supply.

3. The motor starter that **does not** reduce the starting current to a squirrel cage induction motor is:-
   a) the direct on line motor starter;
   b) the star delta starter;
   c) the primary resistance starter;
   d) the auto transformer starter.

4. The main problem with starting large squirrel cage induction motors direct on line is:-
   a) starting torque is greater if a primary resistance starter is used;
   b) the large starting current causes fluctuations in the supply voltage;
   c) the large starting current will cause the motor windings to burn out;
   d) the motor may not produce enough starting torque to start the load.

5. The problem with starting squirrel cage motors with any of the voltage reduction starters is:-
   a) the motor must have all six winding ends brought out to the terminal block;
   b) six wires must be run between the switchboard and the starter;
   c) reducing the voltage causes an even greater reduction in starting torque;
   d) the increased starting torque may damage the load or couplings.

6. The thermal overload used on motor protection:-
    a) interrupts all overloads very quickly;
    b) only isolates short circuits instantly;
    c) allows slight overloads for longer periods;
    d) takes several minutes to isolate any overload.

7. A motor started with a star-delta starter with overloads fitted between the motor and starter would:-
    a) require a thermal overload with six bimetallic elements;
    b) require an overload current rating equal to rated current times $\frac{1}{\sqrt{3}}$
    c) require an overload current rating equal to rated motor current;
    d) require an overload current rating equal to rated current times $\sqrt{3}$

8. An advantage of differential thermal overloads over normal overloads is:-
    a) they can detect the difference between a short circuit and overload fault;
    b) they will protect the motor from loss of one phase of the supply;
    c) they can be used on single, two or three phase motors;
    d) they can also protect against loss of load (ie underload);.

9. Stop buttons and thermal overloads use normally closed contacts because:-
    a) if they get dirty and will not close the machine will not start (fail safe);
    b) normally closed contacts operate quicker than normally open contacts;
    c) normally open contacts would need to be connected in parallel;
    d) normally closed contacts stay cleaner as the dirt cannot get in.

10. AS/NZS 3000 Clause 4.2.1.2 would be satisfied if:-
    a) an automatic reclosing overload device protects the motor under all conditions;
    b) the isolating switch can be locked in the off position if not located next to the motor;
    c) the motor on a saw bench was controlled by a DOL starter operated by pushbuttons;
    d) copper losses vary as the square of the load while other losses are almost constant.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

All starters incorporate one or more______(1)_____to control the motor and _____(2)_____to protect the motor from______(3)_____.At the beginning of the motor circuit (switchboard) either______(4)_____or______(5)_____are used to provide______(6)_____protection for the circuit conductors and the motor.

Starting current to larger motors is required by the______(7)_____Authority to be limited to reduce______(8)_____in the supply. If this is the case the_______(9)_____ cannot be used. However, one of the______(10)_____type starters may be used, depending on current limits and starting torque requirements.

If additional remote pushbuttons are added to a starter all start pushbuttons, which are of the normally______(11)_____contact type, are connected in_______(12)_____and all stop pushbuttons, which are of the normally______(13)_____contact type, are connected in______(14)_____.

When started DOL the starting current of the squirrel cage induction motor is _____(15)_____to_______(16)_____times rated current while starting torque is about _____(17)_____times rated torque. If starting current is reduced the starting torque is reduced in proportion to the______(18)_____. If the reduction of torque is excessive a _____(19)_____induction motor may need to be used.

SECTION C

1. A three phase 415 volt 22 kilowatt delta connected squirrel cage induction motor has a rated line current of 45 amperes and a rated full load speed of 1440 r.p.m. If the motor takes six times rated current, and provides 150 percent of full load torque when started direct on line determine:-

   a) the rated torque produced by the motor; (145.9Nm.)
   b) the starting current taken by the motor; (270A.)
   c) the starting torque delivered by the motor; (218.9Nm.)
   d) the phase current at starting in each winding when connected in delta; (155.9A.)
   e) the current in each winding, and the line current taken from the supply if they were re-connected in star to the supply. (90A.)
   f) the starting torque if the motor were connected in star (hint:- torque produced is proportional to **phase** voltage squared, ie $T_2 = T_1 \, x \left(\frac{V_2}{V_1}\right)^2$ (72.95Nm)

SECTION D

1. Figure 1 is a Torque - Speed curve for a particular motor which takes 140 amperes from the supply when started direct on line. The supply authority requires the starting current to be reduced to a maximum of 100 amperes. To do this the motor voltage is reduced to 0.7 of normal voltage using resistors in series with the motor at starting (primary resistance starter).

   a) Calculate the effect that the reduction of starting voltage would have on the starting torque of the motor; (Hint - reduction of torque = (reduction of voltage)^2).

   b) On Figure 1, draw a new Torque - Speed curve for the motor at the reduced voltage. (Hint - the curve will be reduced vertically by the proportion calculated in (a))

   c) At the reduced voltage would the motor still be able to start:-

      i. the fan (Load A)?

      ii. the pump (Load B)?

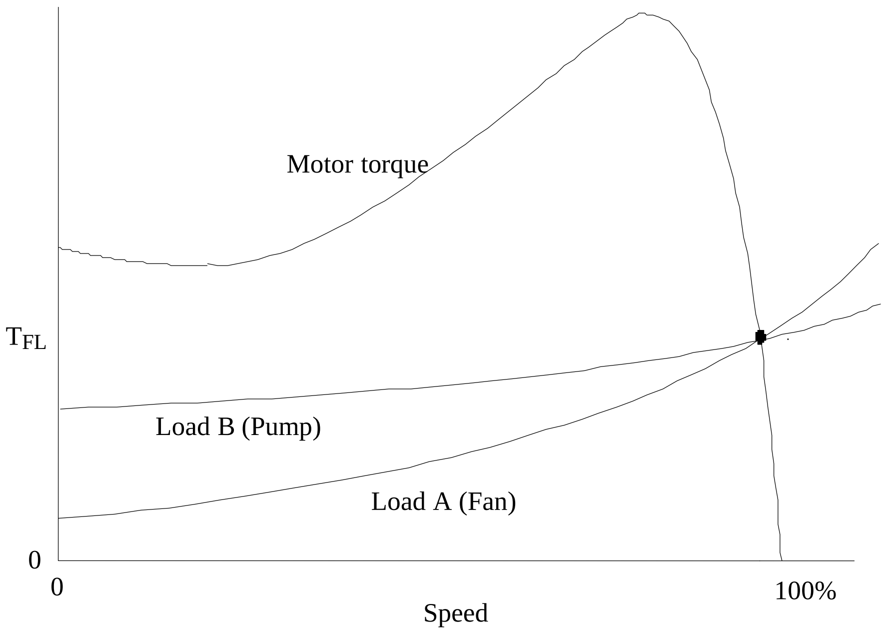


Figure 1

Single Phase Split Phase Motor

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. A single phase winding produces:-

   a) a stationary magnetic field;
   b) a rotating magnetic field;
   c) a steady magnetic field;
   d) an alternating magnetic field.

2. To develop a rotating magnetic field a split phase induction motor simulates a:-

   a) two phase motor;
   b) three phase motor;
   c) series universal motor;
   d) shaded pole motor.

3. If motor load is reduced from full load to three quarters of full load you wouldexpect that:-

   a) speed would increase and current would increase;
   b) speed would decrease and current would decrease;
   c) speed would increase and current would decrease;
   d) speed would decrease and current would increase;

4. The angle of phase displacement between the start and run winding currents of asplit phase induction motor is approximately:-

   a) 10 degrees;
   b) 30 degrees;
   c) 90 degrees;
   d) 120 degrees.

5. The single phase split phase motor is reversed by:-

   a) reversing the supply connections;
   b) reversing the auxiliary winding connection;
   c) reversing the armature connection;
   d) reversing both the auxiliary winding and armature connections.

6. If the centrifugal switch on a split phase motor goes permanently open circuit:-

   a) the motor will not start;
   b) the start winding will burn out;
   c) the start capacitor will burn out;
   d) starting torque will drop to about half of normal value.

7. The auxiliary winding switch should open when:-
   a) rotor speed is about 25 percent of rated speed;
   b) rated speed is about 25 percent of synchronous speed;
   c) rotor speed is about 75 percent of synchronous speed;
   d) slip speed is about 75 percent of synchronous speed.
8. The run winding in a split phase induction motor is placed in:-
   a) the top of the slot to increase inductance;
   b) the top of the slot to decrease inductance;
   c) the bottom of the slot to decrease inductance;
   d) the bottom of the slot to increase inductance.
9. Variable frequency speed control of split phase motors is not generally usedbecause:-
   a) the capacitor start motor has higher torque;
   b) the starting switch might not operate;
   c) voltage speed control in more efficient;
   d) pole changing gives smoother speed changes.
10. The auxiliary winding of a split phase motor always has:-
   a) a lower power factor than the main winding;
   b) a higher resistance than the main winding;
   c) a lower resistance than the main winding;
   d) a higher power factor than the main winding.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The single phase split phase induction motor has two windings. The______(1)_____or _____(2)_____winding in designed to be permanently connected to the supply, and is placed in the______(3)_____of the slot to_______(4)_____the inductive reactance of the winding to give the current a______(5)_____angle of phase difference with the voltage. The winding is wound with a relatively______(6)_____winding wire so that it does not overheat, giving the winding a relatively______(7)_____ resistance.

The other winding, called the______(8)_____or_______(9)_____ winding is designed for short periods of operation and will______(10)_____if left connected for long periods. It is wound with______(11)_____wire than the other winding and has a _____(12)_____number of turns. This gives it a relatively_______(13)_____resistance and______(14)_____inductive reactance, making the phase angle between the winding current and voltage______(15)_____than that of the first winding.

The winding is turned off at about_____(16)____ percent of synchronous speed by either a______(17)______ switch in the motor or a______(18)_____ relay which turns off when the current in the_____(19)_____ winding______(20)_____ to almost rated current.

The windings are displaced by______(21)_____electrical degrees around the stator, and the phase angle between the two currents, which is typically______(22)_____ electrical degrees is adequate to produce an imperfect rotating magnetic field sufficient to start the motor on______(23)_____torque loads. The motor is reversed by reversing the connections on______(24)_____winding.

SECTION C

1. A single phase 240 volt 50 hertz 4 pole split phase motor runs at rated speed of1425 r.p.m. For full load determine:-

   a) the synchronous speed of the motor; (1 500 r.p.m.)
   b) the slip speed; (75 r.p.m..)
   c) the slip percent; (5%.)
   d) the rotor frequency. (2.5Hz)

SECTION D.

1. Figure 1 represents some torque speed curves for a single phase split phaseinduction motor.

   a) Which curve represents the torque speed characteristic for the main windingonly.

   ____

   b) If the centrifugal switch opens when the slip is 25 percent trace on the curves the total torque speed characteristic for the motor showing the transition fromstart to run condition.

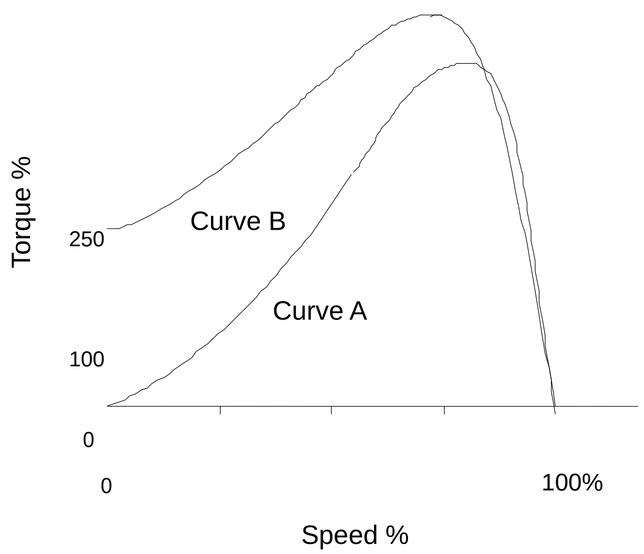
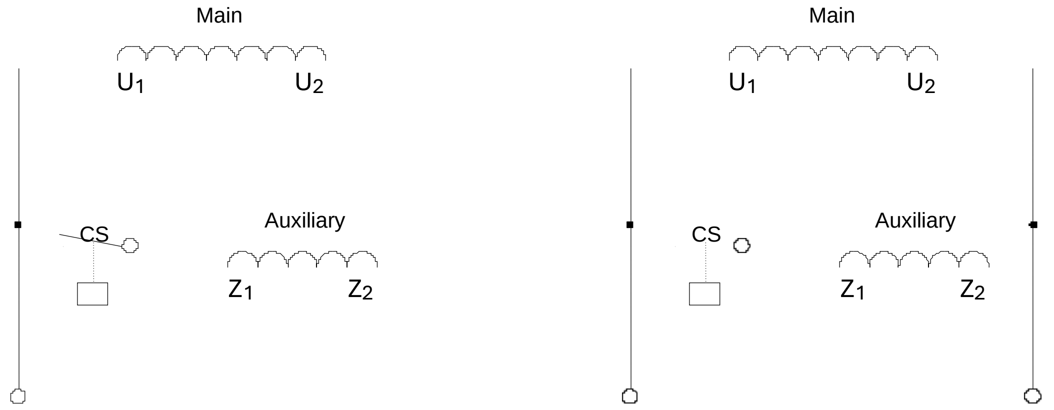


Figure 1

2. Figures 2(a) and (b) show the windings and centrifugal switch for a single phase split phase motor. Complete the circuit to show the connections for both forward and reverse rotations.



AC Supply

Figure 2 (a)

AC Supply

Figure 2 (b)

Capacitor & Shaded Pole Motors

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The capacitor start induction motor has a capacitor connected:**-**

a) in series with the auxiliary winding during starting;
b) in series with the running winding during starting;
c) in parallel with the main winding during starting;
d) in parallel with the start winding during starting.

2. The single phase induction motor that is commonly used to drive cooling fans insmall appliances is the:-

a) permanently split capacitor motor;
b) shaded pole motor;
c) series universal motor;
d) split phase induction motor.

3. A capacitor start induction motor has an open circuited capacitor. The motor will:-

a) start with reduced torque;
b) fail to start;
c) start normally but stop when the centrifugal switch operates;
d) start in the reverse direction.

4. Impedance protection of shaded pole motors:-

a) reduces overheating when stalled;
b) reduces the starting current;
c) reduces unwanted tripping of overload devices;
d) limits motor current on no load.

5. Electrolytic capacitors are used in starting circuits:-

a) because of their low leakage current;
b) because of their small size;
c) because they are continuously rated;
d) because of their high dielectric strength.

6. If the centrifugal switch on a split phase motor goes permanently open circuit:-

a) the motor will not start;
b) the start winding will burn out;
c) the start capacitor will burn out;
d) starting torque will drop to about half of normal value.

7. The shading coils on a shaded pole motor are used to:-
    a) cause the flux to move across the pole face;
    b) reduce the noise of the motor;
    c) prevent the rotor "poling" or "cogging" with the stator;
    d) allow the motor to be reversed easily.
8. A starting switch is not required in:-
    a) a capacitor start, capacitor run motor;
    b) a split phase motor;
    c) a capacitor start motor;
    d) a shaded pole motor.
9. The single phase motor which would produce the highest starting torque whencompared to other motors of a similar rating is the:-
    a) split phase capacitor start;
    b) shaded pole;
    c) split phase;
    d) universal.
10. On a capacitor start, capacitor run induction motor the start capacitor may beidentified as having:-
    a) the lower capacitance and a continuous rating;
    b) the higher capacitance and a continuous rating;
    c) the lower capacitance and a short term rating;
    d) the higher capacitance and a short term rating.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The split phase motor has a maximum phase angle between the main and auxiliary winding currents of approximately______(1)_____degrees. This angle is increased to approximately______(2)_____degrees to produce improved starting characteristics by connecting a capacitor in_______(3)_____with the_______(4)_____winding. This makes the current in the start winding ____(5)____ the current in the run winding. There is a large ____(6)____ in starting torque due to the addition of the capacitor during starting, while the torque produced is the same as the split phase motor _____(7)_____the switch has operated, which occurs at about_______(8)_____ percent of synchronous speed. As with any induction motor, the initial starting current of the capacitor start motor is______(9)_____and______(10)_____as the motor accelerates to its operating speed. In larger motors the centrifugal switch may be replaced with a current relay with it's coil in series with the______(11)_____winding.

The relay closes when the start current is______(12)_____and opens when motor speed______(13)_____and current_______(14)_____.

In the capacitor start, capacitor run motor the run capacitor has a______(15)_____ value of capacitance than the start capacitor. The start capacitor is only connected in _____(16)_____with the________(17)_____winding during starting, being open circuited by the______(18)_____switch at about_______(19)_____percent slip. The run capacitor is left connected in______(20)____with the_______(21)_____winding at all times the motor is running.

The______(22)_____motor has two identical windings displaced by_______(23)_____ electrical degrees around the stator. The______(24)_____may be connected in series with either winding depending on the desired_____(25)_____of rotation.

In the______(26)_____motor, a short circuited turn of copper, or "***shading coil***", is fitted around one tip of each pole of the motor. This causes flux changes in the shaded part o the pole to occur______(27)_____the same changes occur in the rest of the pole. As a result flux moves______(28)_____the shaded side of the pole, creating a small torque in that direction. To reverse a shaded pole motor the______(29)_____must be _____(30)_____in the stator.

SECTION C

1. A single phase 240 volt 50 hertz capacitor start induction motor has a run windingwhich takes 4 amperes at 0.6 lag power factor at start while the start winding/capacitor takes 3 amperes at 0.8 lead power factor. Determine:-
   a) the phase angle of each current and the angle between them; (53.1°lag,36.9°lead, 90°)
   b) the total current taken by the motor at starting. (5A.)
   c) the voltage across the 35uF capacitor. (273V.)

SECTION D.

1. This question relates to the motor illustrated in Figure 1 below.
   a) Identify the type of motor illustrated in Figure 1.
   b) Identify the parts of the motor labelled A, B, C and D.
   c) Is the direction of rotation of the motor clockwise or anti-clockwise?

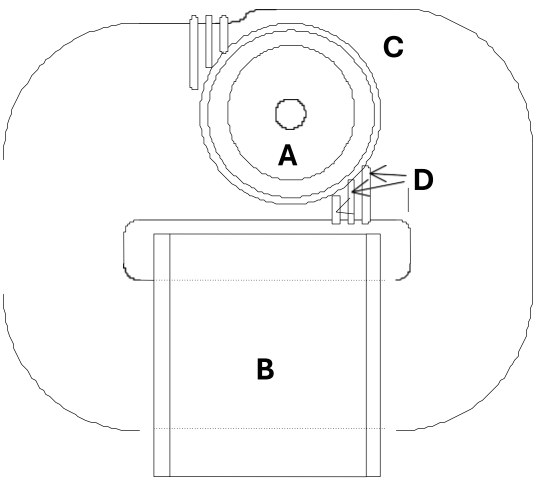
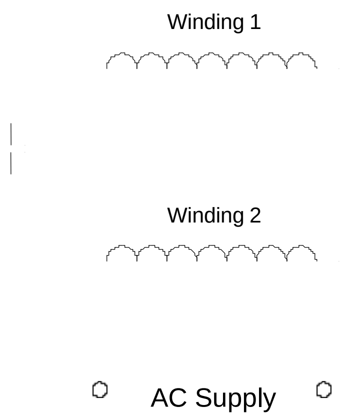
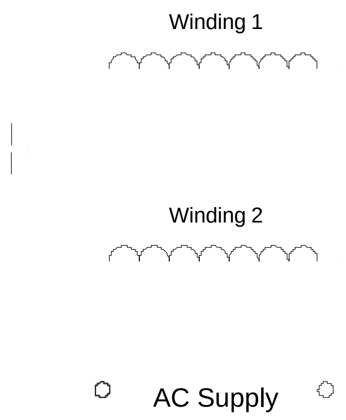


Figure 1

2. Figures 2(a) and (b) show the windings and capacitor for a permanent split capacitormotor. Complete each circuit for different directions of rotation.



<u>Figure 2(a)</u>



<u>Figure 2(b)</u>

NOTE

NOTE

SERIES UNIVERSAL MOTORS

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. A single phase motor rated at 240 volt, 500 watt, 6000 r.p.m., 3 amperes, 50 Hzwould be:-
   a) a split phase motor;
   b) a shaded pole motor;
   c) a series universal motor;
   d) a permanent capacitor motor.

2. Voltage speed control of a constant torque load may be used with:-
   a) shaded pole motors;
   b) split phase motors;
   c) capacitor start motors;
   d) series universal motors.

3. The series universal motor is reversed by:-
   a) reversing the supply connections;
   b) reversing the armature and field connections;
   c) physically reversing the rotor in the field;
   d) reversing the armature connections.

4. A series universal motor driving a constant torque load has its armature voltagereduced from 200 volts to 100 volts using a series resistor. The result will be:-
   a) motor speed will remain unchanged;
   b) motor speed will double;
   c) motor speed will drop to half rated speed;
   d) motor current will decrease to half rated current.

5. The motor used in most mains powered portable hand tools is the:-
   a) shaded pole motor;
   b) split phase motor;
   c) capacitor start motor;
   d) series universal motor.

6. A series universal motor is identified by:-
   a) its universal
   b) its commutator
   c) its series winding
   d) its nameplate

7. The most commonly used motor for a 240 volt single-phase vacuum cleaner is:-

   a) split phase type;
   b) universal type;
   c) capacitor start type;
   d) shaded pole type.

8. A starting switch is not required in:-

   a) a capacitor start, capacitor run motor;
   b) a split phase motor;
   c) a capacitor start motor;
   d) a series universal motor.

9. A small shaded pole fan motor has new coils fitted to change the voltage rating ofthe motor. When re-assembled the fan rotation is reversed. This is most easily rectified by:-

   a) removing the new coils and turning them over;
   b) reversing the current in the motor winding;
   c) reversing the current in the shading coils;
   d) turning the rotor end for end.

10. For a given load the constant speed of a motor occurs when:-

   a) the input power is equal to the output power;
   b) the efficiency of the motor is at a maximum;
   c) the motor output torque equals the load input torque;
   d) the motor slip is at a maximum.

NOTE

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The series universal motor has a______(1)_____starting torque. As the motor accelerates the back emf______(2)_____causing the motor current to_______(3)_____ which______(4)_____the strength of the stator and armature magnetic fields _____(5)_____torque and_______(6)_____speed. The motor will continue to accelerate until it reaches a speed at which the developed______(7)_____equals that required by the load. If the load on the motor increases the motor speed _____(8)_____, back emf_______(9)_____, motor current_______(10)_____, producing______(11)_____ flux and______(12)_____ torque to meet the increase in load. The speed of the series universal motor is______(13)_____on no load and very _____(14)_____on heavy loads.

In the universal series motor both the armature and field are laminated to reduce _____(15)_____loss and made from silicon steel to reduce_______(16)_____loss. The field windings and armature are connected in______(17)_____but as the armature has two parallel circuits between the brushes the armature conductors may be _____(18)_____than the field conductors. If an open circuit occurs in an armature coil this will cause_______(19)_____at the commutator as the brush shorts out the open circuited coil.

SECTION C

1. A 240 volt series universal motor has a total winding/armature impedance of 60ohms. Determine:-
   a) the current taken by the motor at starting; (4A)
   b) the current taken by the motor when armature back emf is 120 volts. (2A.)
   c) the armature back emf when the motor takes rated current of 1.5 amperes;(150V)
   d) the starting torque as a percentage of rated torque if torque is proportional tocurrent squared; (711%)
2. A 240 volt series universal motor drives a constant torque load at rated load and rated current of 7 amperes at 4 000 r.p.m. If speed is to be reduced to 2 500 r.p.m.determine:-
   a) the voltage required (hint: at constant torque, speed is proportional tovoltage);(150V)
   b) the value of series resistance required to drop motor voltage to thisvalue.(12.86Ω)

SECTION D

1. The performance curves for a 240V, 50Hz, 45 watt single phase motor are shownbelow in Figure 1. From these curves estimate the following:-
   a) starting torque;
   b) full load torque;
   c) full load current;
   d) full load speed;
   e) breakdow ntorque;
   f) number of poles;
   g) slip speed at full load.

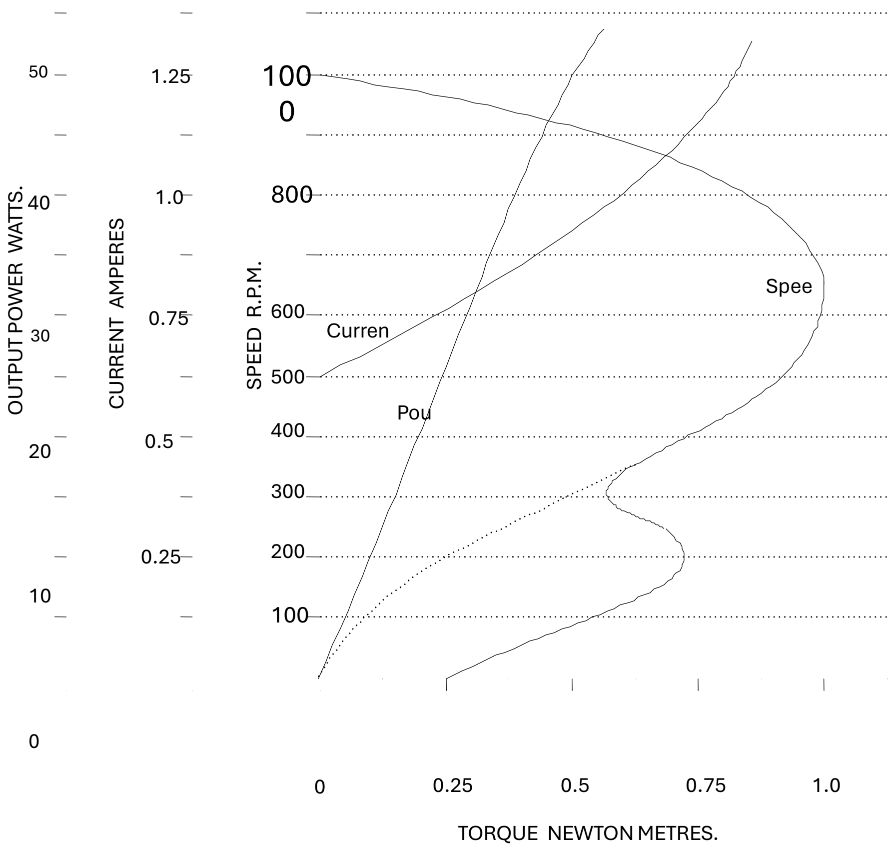


Figure 1.

2. For the current directions given in the series universal motor of Figure 2 determineand show:-
   a) the polarity of the field poles;
   b) the direction of the armature flux and pole location;
   c) the direction of rotation of the motor.

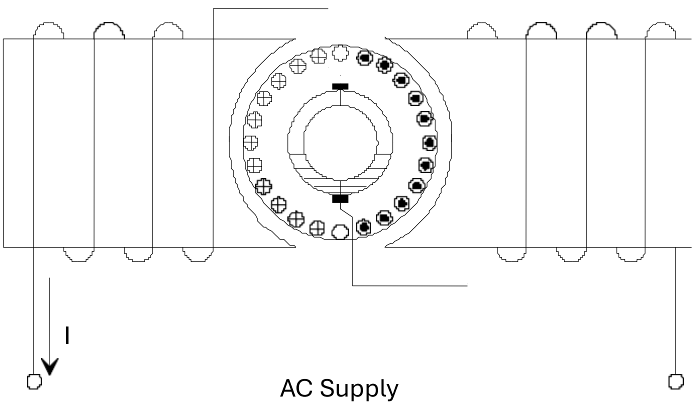


Figure 2.

ALTERNATORS – PART 1

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. Alternators are generally run at a constant speed to maintain:-
   a) a constant output voltage;
   b) a constant load current;
   c) maximum efficiency;
   d) a constant output frequency.

2. Low speed rotating field alternators use:-
   a) salient pole rotors with many poles;
   b) cylindrical rotors with many poles
   c) salient poles rotors with two poles
   d) cylindrical rotors with two poles

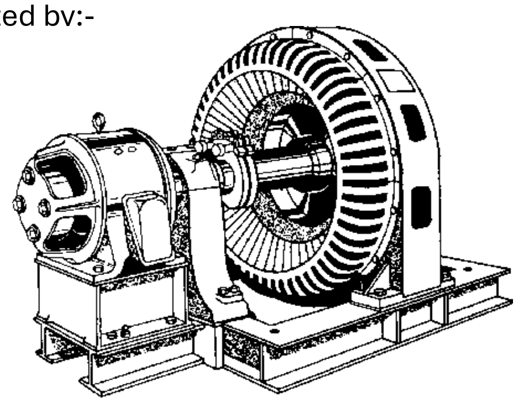
3. The armature winding in a rotating field alternator is placed:-
   a) in slots in the laminated stator core;
   b) in slots in the solid stator core;
   c) in slots in the laminated rotor core;
   d) around the poles on the solid rotor core.

4. Most three phase alternators have their armature windings:-
   a) connected to a d.c. supply for excitation;
   b) connected to an a.c. supply for excitation.
   c) connected in star to allow earthing of the star point;
   d) connected in delta to increase the generated output voltage.

5. Cylindrical rotors are used in 50 Hz alternators with:-
   a) many poles driven at high speed;
   b) few poles driven at high speed;
   c) many poles driven at low speed;
   d) few poles driven at low speed.

6. A suitable rating for a 50 hertz three phase alternator required to deliver a balancedline current of 100 amperes to a 400 volt delta connected load at 0.8 lag power factor would be:-
   a) 40 kVA
   b) 32 kW
   c) 70 kVA
   d) 55 kW

7. The armature winding in an alternator is rewound with the number of turns in eachcoil increased by twenty percent. This will:-
   a) increase the output current by 20%;
   b) increase the output voltage by 20%;
   c) increase the kVA rating by 40%;
   d) all of the above.
8. An alternator, and it's excitation generator are shown in Figure 1. The outputvoltage of the alternator is adjusted bv:-
   a) adjusting the field current in the d.c. generator;
   b) adjusting the speed of the d.c.generator;
   c) adjusting the three phase alternatorsupply voltage;
   d) adjusting the number of turns in thealternator field.



9. The open circuit characteristic of an alternator shows how:-
   a) generated voltage varies with field current;
   b) frequency varies with field current;
   c) generated voltage varies with frequency;
   d) speed varies with frequency.
10. Large alternators place the high voltage a.c. armature winding on the stator. This isbecause -
   a) this winding is larger than the field winding and the stator has more room;
   b) high voltage windings are easier to insulate if they are not rotating/vibrating;
   c) this allows the use of two low current slip rings rather than four high currentones;
   d) all of the above.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The three phase armature windings in alternators are generally connected in _____(1)_____.

The windings of three phase alternators are spaced______(2)_____electrical degrees apart.

The field windings of an alternator are connected to a______(3)_____supply.

In a low speed rotating field type 50 Hz alternator the field system would have a _____(4)_____number of poles and the rotor would be of the______(5)_____type.

The open circuit characteristic of an alternator shows the change in______(6)_____ voltage when the______(7)_____current is changed.

Small alternators may be of the rotating______(8)_____type while large alternators are normally of the rotating______(9)_____type.

The frequency of the emfs produced by an alternator is directly proportional to _____(10)_____and_______(11)_____.

Cylindrical rotors are generally used in______(12)_____speed alternators and normally have a______(13)_____number of poles.

When the rotor in a 6 pole alternator has completed one revolution it will have generated______(14)_____complete cycles and passed through______(15)_____ electrical degrees.

If a star connected alternator in a power station is generating 15kV in each winding the output line voltage will be______(16)_____kV.

The winding in the alternator that generates the output voltage is termed the _____(17)_____winding, regardless of whether it is on the rotating or stationary part of the machine.

The generated voltage of an alternator may be increased by______(18)_____the _____(19)_____.

In a star connected alternator the phase angle between the phase and line voltages is _____(20)_____degrees.

SECTION C

1. At what speed must a 24 pole 50Hz alternator in a Hydro-electric power station bedriven? (250 r.p.m.)
2. How many poles would be required on a 25Hz alternator running at 375r.p.m.? (8poles)
3. Is it possible to design a 50Hz alternator that runs at 1200 r.p.m.?. Explain youranswer.
4. A three phase star connected 50Hz alternator is to be used as an emergency supply with an output line voltage of 11kilovolts. What voltage must be generated in eachphase winding? (5.6kV).
5. A 2 pole, 50 Hz, three phase, star connected alternator has a winding constant of0.97, a flux per pole of 81.mWb and 364 turns in the windings of each phase. Determine:-
   a) the speed of rotation of the alternator; (3 000r.p.m.)
   b) the generated phase voltage; (6 350V.)
   c) the output line voltage. (11 000V.)

SECTION D

1. Name the curves shown in Figure 2.
2. Why are there two curves in the graph? What does each curve represent?.
3. Starting from zero amperes how far must field current be increased to give an outputvoltage of 250 volts?
4. Will generated voltage drop to zero volts when field current is reduced to zeroamperes? Give reasons for your answer.

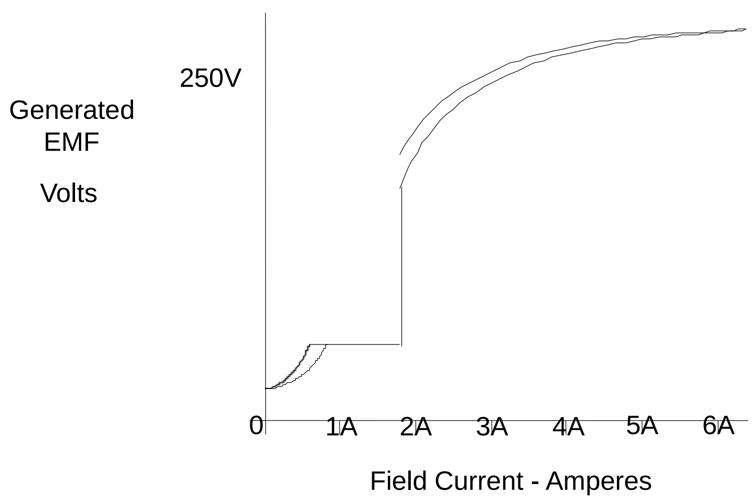


Figure 2

ALTERNATORS – PART 2

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The efficiency of an alternator is the ratio of:-
   a) kVA output to kVA input;
   b) kW output to kW input;
   c) kVA output to kW input;
   d) kW output to kVA input;
2. The terminal potential difference of a three phase 50 hertz alternator is adjusted tothe required value by means of:-
   a) altering the field excitation;
   b) changing the speed
   c) using a tapped winding;
   d) adjusting the number of poles.
3. Modern large alternators use hydrogen cooling. This is done to:-
   e) prevent the windings from oxidising;
   f) reduce the rotational losses in the machine;
   g) reduce the load on the alternator bearings;
   h) reduce air pollution caused by arcing.
4. Alternators are connected in parallel to:-
   a) increase the output voltage supplied to the load;
   b) increase the output current supplied to the load;
   c) allow two alternators to be driven by one prime mover;
   d) because two small alternators are more efficient than one large one.
5. As the power factor of a constant current load with a lagging power factor isimproved towards unity power factor the t.p.d. of the alternator will:-
   a) increase;
   b) decrease;
   c) remain unchanged;
   d) depend on load frequency.
6. Alternators are rated in terms of:-
   a) speed and voltage;
   b) current and voltage;
   c) voltage and kVA;
   d) voltage and kW.

7. An alternator normally designed with a high voltage regulation to:-
   a) control output voltage;
   b) limit short circuit current;
   c) reduce losses in windings;
   d) limit open circuit speed.
8. If the terminal voltage on an alternator increases as load increases the type of load isa:-
   a) modern highly efficient load;
   b) lagging power factor load;
   c) unity power factor load;
   d) leading power factor load.
9. The load characteristic of an alternator shows the manner in which the:-
   a) excitation varies with load;
   b) speed varies with excitation;
   c) t.p.d. varies with load;
   d) t.p.d. varies with excitation.
10. Armature reaction in an alternator causes:-
   a) a reduction in torque due to load current;
   b) a change in field flux as load power factor changes;
   c) an increase in armature speed as load increases;
   d) a decrease in armature speed as load increases.

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

The percentage rise in terminal voltage of an alternator when full load is removed is called it's______(1)_____.

The load characteristic of an alternator is a graph showing the variation in terminal voltage when a change occurs in the______(2)_____current.

The effect of armature reaction in an alternator supplying a lagging power factor load is to______(3)_____the t.p.d. compared to an equivalent unity power factor load.

Variations in t.p.d. which may occur due to changes in load on an alternator are minimised by the use of_____(4)_____.

Voltage regulation of an alternator is the difference between no-load voltage and full-load voltage expressed as a percentage of_____(5)_____voltage.

When operating alternators in parallel the load share of one alternator may be increased by increasing the______(6)_____on the_______(7)_____.

When the rotor in a 6 pole alternator has passed through one complete revolution it has completed______(8)_____electrical degrees.

Alternators are rated in kVA rather than kW because the voltage and kVA rating can be used to determine the maximum______(9)_____ that the______(10)_____can withstand..

The output voltage of an alternator is maintained constant as load current changes by using a______(11)_____to monitor output voltage and adjust______(12)_____.

SECTION C

1. An alternator has a t.p.d. of 415 volts when delivering full load at unity power factor. Calculate the no load t.p.d. if the alternator has a voltage regulation of 13percent. (468.95V)
2. A three phase 6 600 volt alternator supplies a current of 2 200 amperes at full load.Determine:-
   a) the rated kVA output; (25.15MVA or 25 150kVA)
   b) the output power at 0.8 lagging power factor. (20.1MW or 20 100kW)
3. An alternator with a full load t.p.d. of 415 volts has the terminal voltage increase to 499 volts on no load. Determine the percentage voltage regulation for the alternator.(20.24%)
4. The terminal voltage of a 70MVA, three phase, 50 hertz, star connected alternator is11.7kV. If the armature winding has a breadth factor (k) of 0.956 and the armature winding has 16 turns per phase determine:-
   a) the maximum flux per pole; (1.98Wb)
   b) the full load current rating of the alternator. (3 454A.)
5. The 70MVA alternator in the previous question has an efficiency of 92 percent when operating at full load and 0.8 power factor. Determine the power output of theprime mover at this load. (60.87MW)

SECTION D

1. For the alternator load characteristic curves shown in Figure 1:-

a) indicate whether curve A, B and C are lagging, leading or unity power

factor;A:-______________________power factor;

B:-____________________________power factor;

C:-____________________________power factor;

SECTION A

In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. The speed of a synchronous motor:-
   a) depends on supply frequency;
   b) depends on the size of load;
   c) depends on both frequency and load;
   d) is constant regardless of frequency and load;

2. The operating power factor of a synchronous motor:-
   a) is affected by phase sequence of the supply:
   b) is affected by field excitation;
   c) is constant regardless of any changes;
   d) improves as load increases.

3. "Normal excitation" of a synchronous motor at full load:-
   a) is the rated field current on the nameplate;
   b) gives minimum power factor and maximum current;
   c) gives minimum power factor and minimum current;
   d) gives unity power factor and minimum current.

4. Synchronous motors develop a torque by:-
   a) electromagnetic induction between stator and rotor;
   b) mutual induction between stator and rotor;
   c) attraction between stator and rotor fields;
   d) stator field hunting the rotor field.

5. The advantages of operating a synchronous motor with "over excitation" are:-
   a) increased pull out torque and increased power factor;
   b) decreased line current and a leading motor power factor;
   c) decreased line current and a leading motor power factor;
   d) increased pull out torque and a leading motor power factor.

6. The "V Curves" of a synchronous motor show how:-
   a) line current and speed vary with excitation;
   b) line current and power factor vary with excitation;
   c) speed and power factor vary with load;
   d) line current and power factor vary with load.

7. "Pull out torque" of a synchronous motor:-

   a) may be increased by increasing excitation current in the field;
   b) is the maximum torque produced during starting;
   c) varies with variations in load;
   d) decreases as motor speed increases.

8. An "under excited" synchronous motor would operate with:-

   a) a leading power factor at more than synchronous speed;
   b) a leading power factor at synchronous speed;
   c) a lagging power factor at synchronous speed;
   d) a lagging power factor at less than synchronous speed.

9. Synchronous motors are:-

   a) all self starting and produce high starting torque;
   b) started as induction motors or with a pony motor;
   c) started as a d.c. motor by connecting d.c. to the stator;
   d) started as a slip ring motor by connecting a.c. to the rotor.

10. Damper windings or amortisseur windings are used in synchronous motors to:-

   a) start the motor and reduce hunting on reciprocating loads;
   b) reduce the amount of direct current required in the field windings;
   c) reduce the amount of current taken from the supply during starting;
   d) bring the motor to a stop quickly after being turned off.

NOTE

SECTION B

Blank spaces in the following statements represent omissions. Write the appropriate information on your answer sheet.

As load on a synchronous motor increases the load or torque angle will _____(1)_____. This angle is the angle between the centres of_____(2)_____and _____(3)_____poles.

The term "synchronous capacitor" is used to describe a______(4)_____motor which has been______(5)_____excited.

If the exciter is used to bring the synchronous motor up to speed it is necessary to have a separate______(6)_____supply.

A three phase synchronous motor may be started as an induction motor if the motor is fitted with_____(7)_____windings.

If a pony motor is used to bring a synchronous motor up to speed it is necessary to start the motor on______(8)_____load or have a______(9)_____between the motor and load.

The synchronous induction motor uses a rotor similar to a _____(10)_____motor, is started with______(11) connected in the rotor circuit, which is disconnected and reconnected to a______(12)_____when close to synchronous speed.

The stator winding of the synchronous motor, when connected to a three phase supply, produces a_____(13)_____magnetic field at______(14)_____speed.

A three phase synchronous motor with a four pole salient pole rotor would have _____(15)_____slip rings, and a stator winding which produces a______(16)_____ pole field.

SECTION C

1. A four pole synchronous motor is connected to a 60Hz supply. Determine the speedof the motor. (1 800 r.p.m.)
2. A three phase four pole 415 volt synchronous motor takes a current of 75 amperes atfull load with normal excitation while driving a 50kW load. Determine:-
   a) the input power to the motor; (53.91kW)
   b) the efficiency of the motor under these conditions; (92.75%)
   c) the speed of the motor; (1 500r.p.m.)
   d) the torque delivered to the load at normal excitation; (318.3Nm)
   e) the current taken if excitation is reduced until power factor is 0.8 lagging.(93.75A)

SECTION D

1. For the curves drawn for a three phase synchronous motor shown in Figure 1:-

a) What do we call this family of curves?

b) Use the labels on the curves (A, B, C, and D) to indicate which curve is:-

   i. the curve of power factor vs field current for no load;

   ii. the curve of power factor vs field current for full load;

   iii. the curve of stator current vs field current for no load;

   iv. the curve of stator current vs field current for full load.

c) What is the value of field current for the motor at normal excitation on full load?

d) What is the value of stator current taken by the motor at normal excitation on noload?

e) If the field current is 4 amperes while the motor is driving full load:-

   i. What is the stator current taken?

   ii. What is the power factor?

   iii. Is the power factor leading, lagging or unity?

   iv. Is the motor under, over or normally excited?

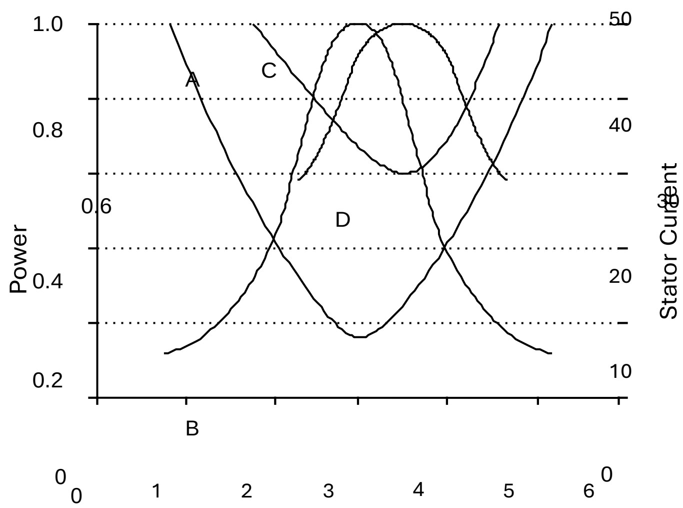


Figure 1

BASIC RELAY CIRCUITS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. The three main parts of a relay are the coil, the iron core and the contacts. Draw a diagram showing the basic construction of a relay.

2. Briefly explain the function of each of the three main parts of a relay.

   a) ____

   ____

   b) ____

   ____

   c) ____

   ____

3. Explain the meaning of a relay being:

   a) de-energised -

   ____

   ____

   b) energised. -

   ____

   ____

4. Draw the Australian Standard drawing symbol for each of the following components:

normally open pushbutton	
normally closed pushbutton	
normally open relay contact	
normally closed relay contact.	

5. Explain the difference in operation between a manual switch and a pushbutton switch.

6. What is the purpose of using a latching contact in a relay circuit?

7. Using semi-detached symbols, draw a circuit diagram for the circuit that operates in the following manner:

- Closing a manual switch S1 energises a relay coil R
- energising the relay coil causes a pilot light L1 to turn on via a set of relay contacts R1
- energising the relay coil causes a pilot light L2 to turn off via a set of relay contacts R2

8. Draw the circuit diagram for the circuit that operates in the following manner:

   a) the coil of a relay R/4 has on/off control provided by two pushbuttons S1 and S2
   b) when the relay is de-energised lamp L1 is to be on and lamp L2 is to be off
   c) the relay has two normally open and two normally closed contacts
   d) when the on pushbutton (S1) is pressed the relay is to be held in the energised condition by a latching contact.

9. What is the purpose of wire numbering as used on a circuit diagram?

10. Describe the operation of the circuit shown in figure 1. Assume the circuit is originally de-energised.

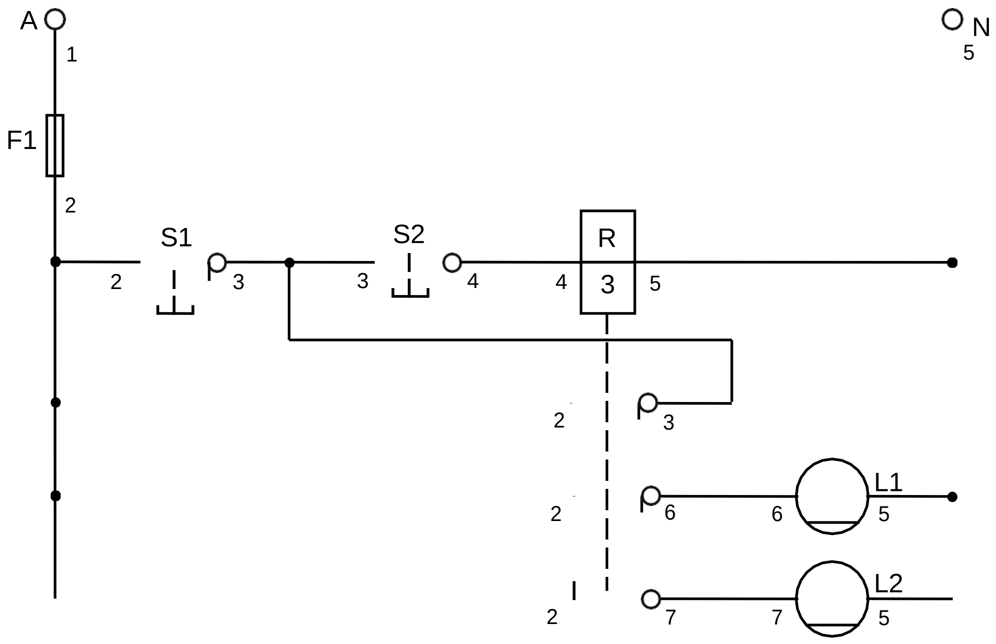


Figure 1

RELAY CIRCUITS & DRAWING CONVENTIONS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. List five factors that must be considered when selecting a control relay.

   i. ______________________________

   ii. ______________________________

   iii. ______________________________

   iv. ______________________________

   v. ______________________________

2. Briefly explain the advantages of detached relay symbols.

   ____

   ____

3. A relay is labeled $\boxed{\frac{R}{3}}$ What does the number 3 identify?

   ____

4. What are the two acceptable methods for the drawing of circuit diagrams and what are the drawing conventions applicable to each?

   i. ______________________________

   ____

   ii. ______________________________

   ____

5. Using detached relay symbols draw the circuit diagram for a start-stop station controlling a control relay CR. The control relay is to control a second relay R1. Relay 1 is to be energised when the control relay CR is de-energised and de-energised when the control relay CR is energised.

6. Using the grid on the next page convert the circuit diagram shown in figure 1 to a circuit diagram that has a **vertical** layout.

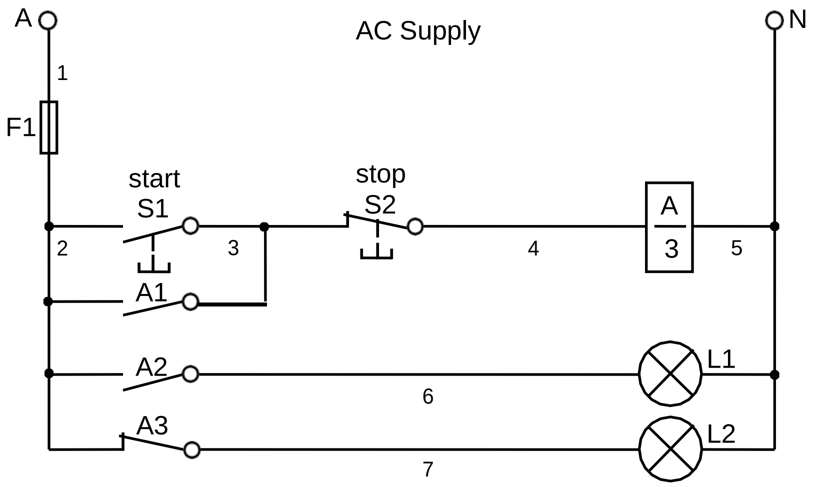


Figure 1

Remote Stop-Start Control &
Electrical Interlocking

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. If a number of start pushbuttons are to be connected into a control circuit, how must the start buttons be connected with respect to one another?

2. If a number of stop pushbuttons are to be connected into a control circuit, how must the stop buttons be connected with respect to one another?

3. What is meant by the term start-stop station?

4. What is the purpose of electrical interlocking?

5. Draw the circuit diagram of a relay controlled from a single start-stop station. Once energised the relay is to latch.

6. Draw the circuit diagram of a relay controlled by both local and remote start-stop stations. Once energised from either location the relay is to latch.

7. Draw a circuit diagram showing how two relays can be interlocked, such that only one relay can be energised at any one time. In your diagram you need only show the coils of the two relays and the interlock contacts.

8. Draw the circuit diagram for a circuit that has to operate as follows -
    - S1, S3 and S5 are normally open pushbuttons
    - S2, S4 and S6 are normally closed pushbuttons
    - pushbuttons S1 and S2 provide start-stop control for relay R1
    - when relay R1 is energised lamp L1 turns on
    - pushbuttons S3 and S4 provide start-stop control for relay R2
    - relay R2 is also controlled by a remote start-stop station, comprised of S5 and S6.
    - when relays R1 & R2 are de-energised, lamp L2 turns on

    Use a horizontal layout and include on your diagram wire numbers, line numbers and relay brackets.

9. Draw the circuit diagram for a circuit that has to operate as follows -

- when power is first applied to the circuit and before any pushbutton is pressed, all relays will be de-energised, lamps L1 and L2 will be off and lamp L3 will be on
- relay R1 will be energised by pressing pushbutton S1 and de-energised by pressing either pushbuttons S2 or S3
- lamp L1 will light when relay R1 is energised
- relay R2 will be energised by pressing pushbutton S4
- relay R2 can only be energised if relay R1 is already energised
- if relay R2 is energised, it will remain energised if relay R1 is de-energised
- to de-energise relay R2, pushbutton S5 must be pressed
- lamp L2 will turn on when relay R2 is energised
- lamp L3 will turn off when relay R2 is energised.

Use a horizontal layout and include on your diagram wire numbers, line numbers and relay brackets.

Fault Finding Electric Circuits

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. List four commonly used items of test equipment used to test and fault find electrical control circuits?

   ____

   ____

   ____

   ____

2. What instrument is used to measure insulation resistance?

   ____

3. what is the minimum acceptable insulation resistance for -
   a) general wiring ______________________________
   b) motor windings ______________________________
   c) heating elements ______________________________

4. When using an ohmmeter to measure the resistances associated with a control circuit, what value of resistance would you expect to measure for -
   a) the coil of a working relay ______________________________
   b) a set of normally open relay contacts ______________________________
   c) a set of normally closed relay contacts ______________________________
   d) a blown fuse ______________________________

5. List five things that can be done within control circuits to prevent the occurrence of faults?

____

____

____

____

____

6. What type of fault is most likely if a circuit breaker, protecting a control circuit, repeatedly trips when reset?

____

7. Can the condition that is open or closed, of a set of relay contacts, be checked in circuit using an ohmmeter without firstly disconnecting at least one connection to the contacts? If not, why not?

____

8. If on opening the panel of a control circuit a distinct smell of burnt varnish is detected, what is a possible circuit problem or fault?

____

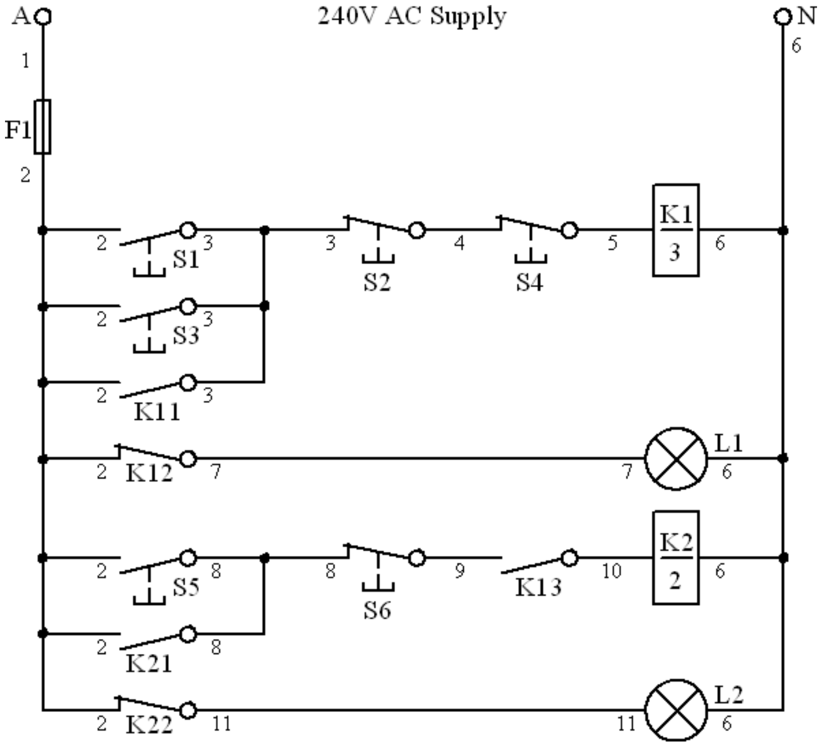


Figure 1

9. Determine the probable faults in the circuit of figure 1, if the following symptoms existed -
   a) Relay K1 will not operate when S1 is pressed. The voltage across the coil of the relay, with S1 pressed, is 240V.

      ____

   b) Relay K1 will not operate when S1 is pressed. A voltmeter connected between wires 2 and 3 measures 240V when S1 is pressed.

      ____

   c) Relay K1 will not latch after S1 is pressed.

      ____

   d) Lamp L1 does not light when power is applied to the circuit. The voltage measured between wires 2 and 6 is 240V and between wires 2 and 7 is 240V.

      ____

   e) Relay K2 will not operate. With relay K1 energised and S5 pressed, a voltmeter connected between wires 8 and 9 measures 240V.

      ____

   f) Relay K2 will not operate. A voltmeter connected between the coil neutral and the supply neutral shows a reading similar to the supply voltage when S5 is pressed.

      ____

   g) The fuse blows at the instant that S1 is pressed.

      ____

   h) The circuit does not operate at all. A voltmeter connected between wires 1 and 6 shows supply voltage, when connected between wires 2 and 6 the voltmeter shows zero voltage.

      ____

   i) Lamp L2 does not light. A voltmeter connected across the shows supply voltage.

      ____

   j) Relay K2 will not de-energise when S6 is pressed.

      ____

TIME DELAY RELAYS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. What are the names given to the two general classifications of time delay relay?

   ____

   ____

2. What is the difference between the operation of the contacts on a control relay and a time delay relay?

   ____

   ____

3. Describe the meaning of the terms -
   a) on delay

   ____

   b) off delay, as applied to time delay relays

   ____

4. Draw the Australian Standard drawing symbols for-

the coil of an on delay timing relay		the coil of an off delay timing relay	
a normally-open contact which is time delayed to close		a normally-closed contact which is time delayed to open	
a normally-open contact which is time delayed to re-open		a normally-closed contact which is time delayed to re-close.	

5. List six factors that must be considered when selecting a time delay relay for a particular application.

____

____

____

____

____

____

6. An on-delay timer has a set of normally open contacts which are time delayed to close. The timer is set for a time delay of 15 seconds. State whether the contacts would be open or closed for each of the following conditions -
   a) prior to power being applied to the coil of the timer ________________________
   b) 5 seconds after power is applied to the timer coil __________________________
   c) 20 seconds after power is applied to the coil of the timer _____________________
   d) power has been removed from the coil of the timer,
      after the timer had timed out. ____

7. An off-delay timer has a set of normally open contacts which are time delayed to re-open. The timer is set for a time delay of 10 seconds. State whether the contacts would be open or closed for each of the following conditions –
   a) prior to power being applied to the coil of the timer _________________________
   b) 5 seconds after power is applied to the timer coil __________________________
   c) 20 seconds after power is applied to the coil of the timer _____________________
   d) 5 seconds after power has been removed from the coil of the timer _____________
   e) 15 seconds after power has been removed from the coil of the timer. ____________

---

8. Describe the operation of the circuit shown in figure 1. In doing so describe the condition of the four power consuming devices for each of the following conditions –
   a) power applied, but prior to S1 being pressed

b) immediately after S1 has been pressed

c) immediately after S2 has been pressed

d) 10 seconds after S2 has been pressed.

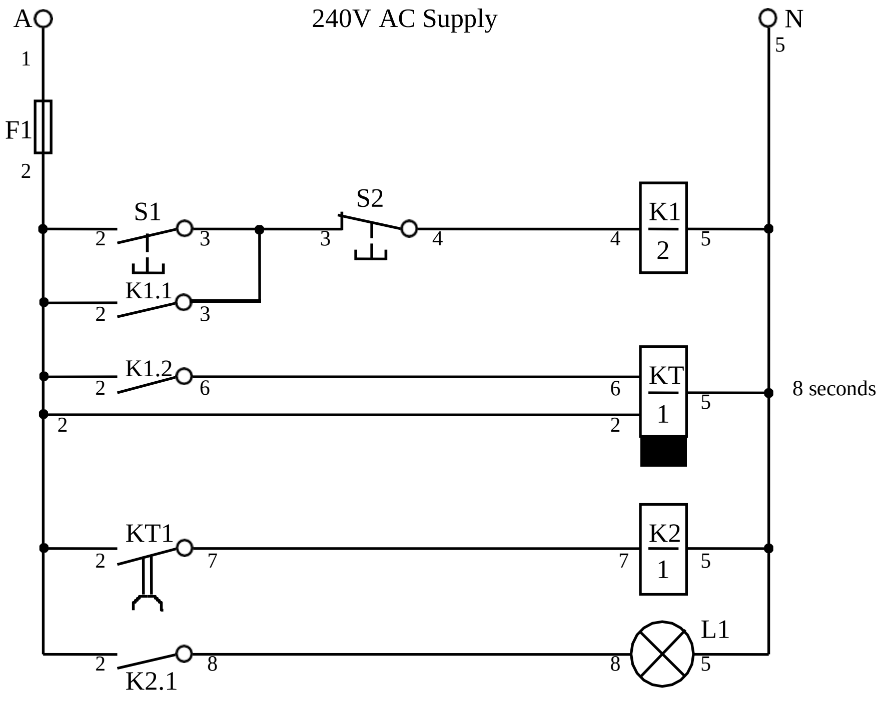


Figure 1

9. Develop and draw the circuit diagram for a circuit that operates in accordance with the following -

- relay R1 is energised and de-energised by pushbuttons S1 and S2 respectively
- energising relay R1 allows it to latch and causes -
  - pilot light L1 to turn on, relay R2 to energise and latch, and the on-delay timer T1 to energise
- after a delay of 10 seconds, the timer contacts cause relay R1 to de-energise, which in turn will turn off L1 and energise relay R3
- energising relay R3 causes pilot light L2 to turn on
- operation of pushbutton S2 will de-energise all relays and all lights.

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. List the 4 major parts of a contactor.

    ____

    ____

    ____

    ____

2. Explain the difference between a relay and a contactor?

    ____

    ____

    ____

3. Draw the Australian Standard symbols for the following parts –

Contactor coil		Power contacts Normally Open	
Auxiliary contacts Normally Open		Auxiliary contacts Normally Closed	
TOL Heaters		TOL N/C Auxiliary contact	

4. List five factors that must be considered when selecting a contactor for a particular application.

5. List three typical applications for contactors.

6. What is the difference between a two pole, a three pole and a four pole contactor?

7. List four factors that must be considered when selecting a thermal overload for a particular application.

8. Draw the circuit diagram for a circuit that operates as follows -

   - a start-stop station is to control two, single phase, 240V heating elements - element A and element B
   - each element is to be switched individually by a its own contactor
   - if the total current taken by the elements becomes excessive a thermal overload will operate and disconnect only element A.

9. Draw the circuit diagram, including both power and control circuits, for a circuit that operates in accordance with the following -

   - a single phase 240V motor is to be controlled by a contactor K2 and protected by a thermal overload and a 10A circuit breaker
   - the control circuit is protected by a 2A circuit breaker
   - a start-stop station is used to switch a control relay K1
   - energising K1 causes a time delay relay KT to energise
   - after a time delay of 15 seconds the contactor K2 energises
   - if the thermal overload trips the entire control circuit is to be de-energised
   - a pilot light L1 is to be included to indicate when the motor is running.

JOGGING CIRCUITS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. Explain the meaning of the term jogging as applied to an electric motor.

   ____

2. In what type of application would you expect to find a jog circuit and explain why it would be used in that situation?

   ____

   ____

3. List three different methods of achieving jog control of an electric motor.

   ____

   ____

   ____

4. What does a double pole jog button consist of and how must its contacts be arranged?

   ____

   ____

5. Which type of motor is more likely to be jog controlled, single phase or three phase?

   ____

6. List six factors that must be considered when selecting a pushbutton for a particular application.

   ____

   ____

   ____

   ____

   ____

   ____

7. Draw the circuit diagram, both power and control circuits, for a 3-phase direct on line (DOL) motor starter that has the following -

   - A local start-stop control
   - thermal overload protection
   - a remote start-stop station.

8. Draw the circuit diagram, both power and control circuits, for a 3 phase direct on line (DOL) motor starter that has the following -

   - start-stop control via pushbuttons
   - thermal overload protection
   - jog control via a double pole jog pushbutton.

9. Draw the circuit diagram, including both power and control circuits, for a circuit that operates in accordance with the following -

   - two 3-phase induction motors are to be individually protected using circuit breakers and thermal overloads
   - when power is applied to the circuit, and before any pushbuttons are pressed, both motors are stopped
   - motor 1 may be started and stopped by using pushbuttons S1 and S2 respectively
   - motor 2 may be started and stopped by using pushbuttons S3 and S4 respectively
   - motor 2 may also be jogged by pushbutton S5. Jog control is provided by a control relay
   - motor 2 cannot run or jog unless motor 1 is running
   - the available supply is 3-phase plus neutral
   - the control circuit is to be supplied with 240V.

CONVERTING WIRING DIAGRAMS

TO CIRCUIT DIAGRAMS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. What are the functions of a wiring diagram?

   ____

   ____

2. List the differences between a wiring diagram and a circuit diagram.

   ____

   ____

   ____

3. Why is it necessary to be able to convert a wiring diagram to a circuit diagram?

   ____

   ____

4. The conversion of a wiring diagram to a circuit diagram is usually carried out in two steps. What are the two steps?

   ____

   ____

5. Convert the wiring diagram of figure 1 to a circuit diagram.

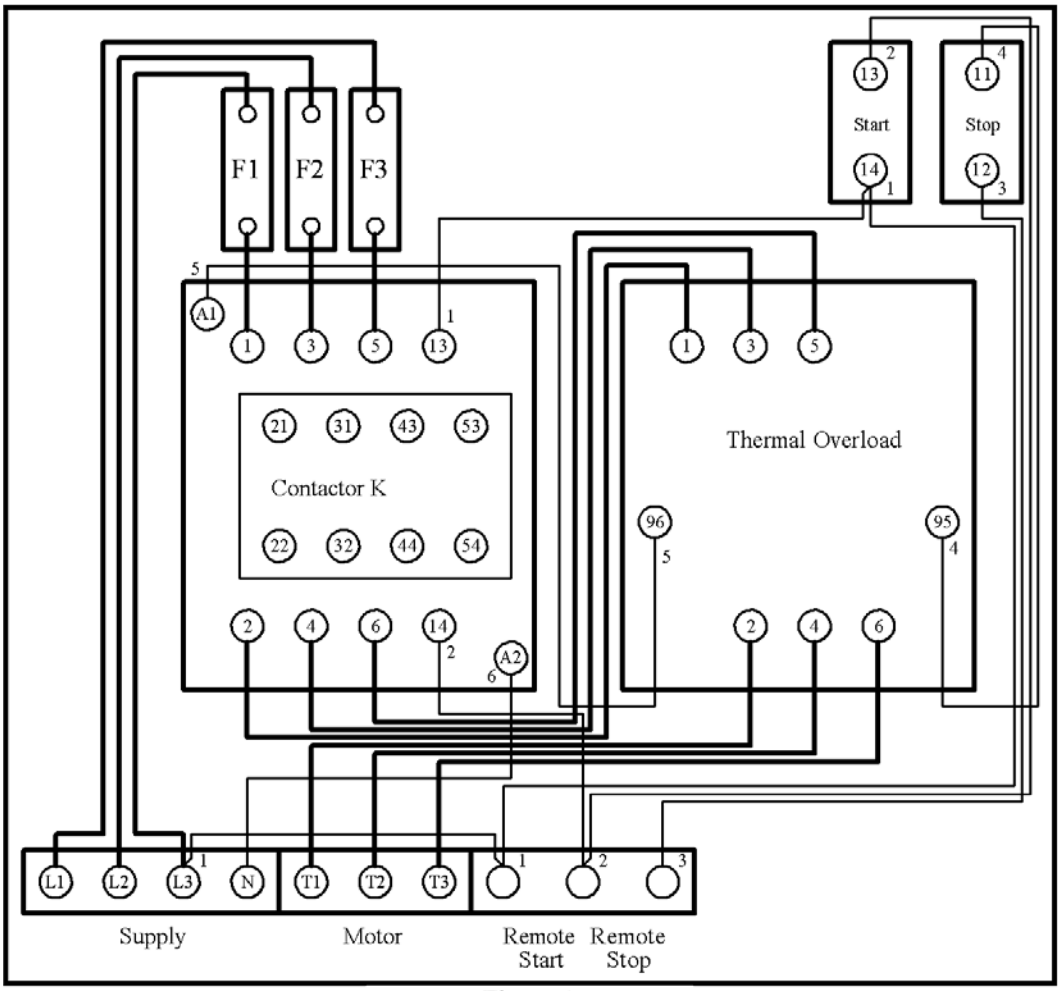


Figure 1

6. Convert the wiring diagram of figure 2 to a circuit diagram.

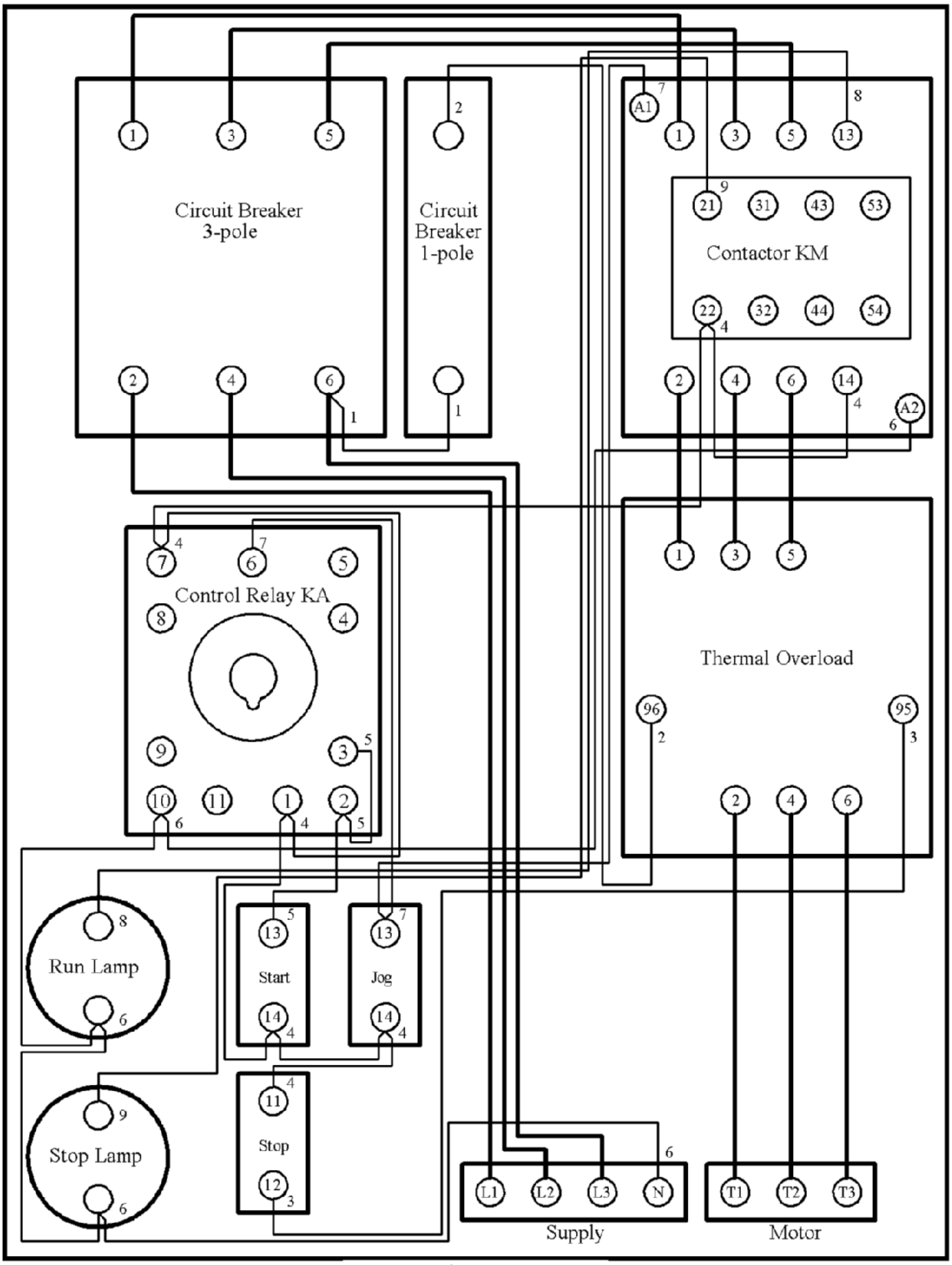


Figure 2

CONTROL DEVICES

SECTION A

1. Name the six parts of a limit switch.

____

____

____

____

____

____

2. Why would a control circuit include limit switches?

____

____

3. Sketch the circuit symbol for the following.

Normally open limit switch		Normally open photoelectric cell	
Normally closed mechanical reed switch		Normally open pressure switch	

Normally open electronic reed switch		Normally closed temperature switch	

4. What is the major difference between a proximity detector (switch) and a limit switch?

____

____

5. What are the two classifications of proximity switches?

____

____

6. What are three classifications of photo-electric detectors?

____

____

____

7. What is meant by the “trip setting” and the “differential setting” for temperaturesensors?

____

____

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Notes

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