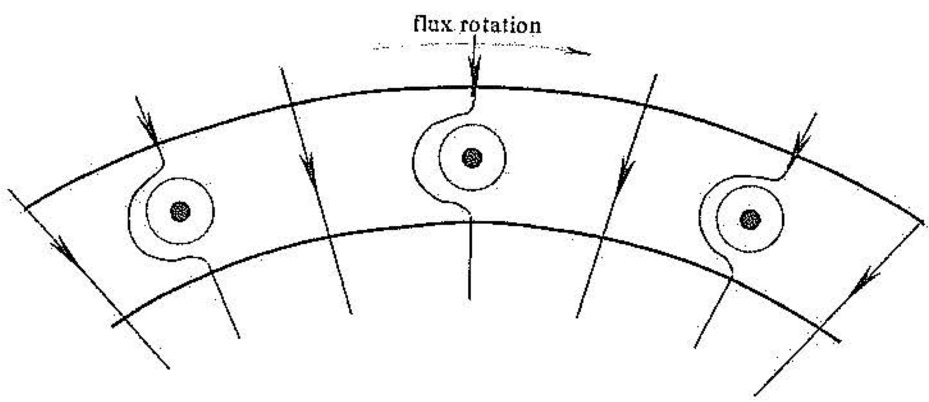
ANSWERS TO REVIEW QUESTIONS

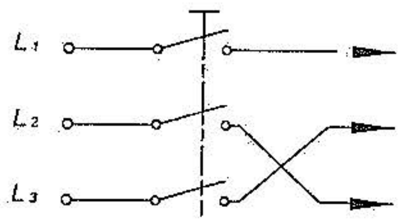
Section 1

1. Two phases.
2. Pulsating
3. Synchronous speed.
4. Phase sequence.
5. Same
6. 1.5
7. Torque
8. Electromagnetic induction.
9. Supply frequency and number of poles.
10. Slip is required to maintain an induced rotor field, so that torque is developed.
11.



12. 750rpm
13. Two poles
14. Since $N_{sync} = \frac{120f1}{P}$ *speed decreases*
15. The rotor field is established by electromagnetic induction between the RMF of the stator and the rotor conductors.

16. B any two lines may be crossed



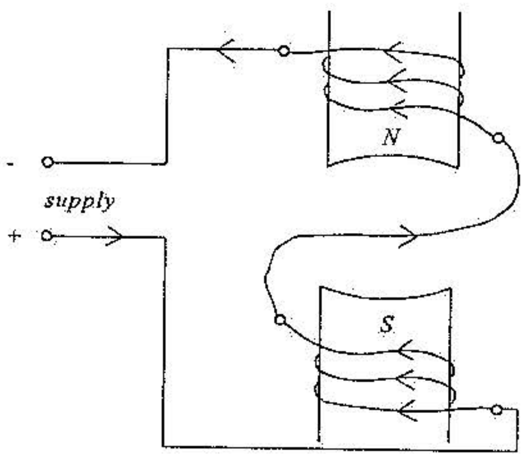
17.

A B

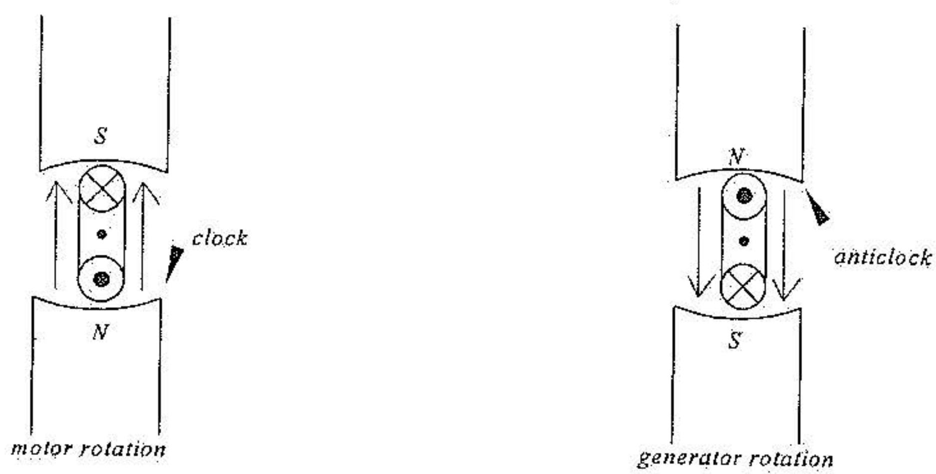
18.

A B

19.



20.



Section 2

1. Interchange any two supply lead connections.
2. Star
3. Reduce eddy current loss.
4. Copper or aluminium.
5. Skewed with respect to the stator slots.
6. None
7. Have no effect on the motor operation.
8. Greater than 1 megohm.
9. 10 to 100 ohms.
10. 0.5mm
11. Wound rotor.
12. Cast into slots in pre-stacked laminated stampings.
13. Totally enclosed.
14. No change.
15. End shields and stator.
16.
    - isolate supply and danger tag
    - check for no supply at motor terminals
    - sketch terminal block connection and tag wiring
    - disconnect wiring
    - witness mark end shields to frame and dismantle

Section 3

1. 735rpm
2. Synchronous speed and rotor speed.
3. When rotor resistance equals rotor reactance.
4. Supply voltage squared.

5. Higher starting torque and higher full-load slip.

6. Rock crusher.

7. Increase with load increases.

8. Increases with slip increases.

9. For low values of slip.

10. Starting torque and current.

11. Increases

12. Zero

13. When rotor resistance equals rotor reactance.

14. The motor stalls.

15. It increases the starting torque.

16 (A) break down torque
(B) starting torque
(C) full load torque
(D) synchronous speed

17. C

18. 960 rpm

19. 4%

20. 67.5Nm

Section 4

1. From AS3000 - Clause 0.5.51:
"Fuse - a device for protecting a circuit against damage from an excessive current flowing in it by opening the circuit on the melting of the fuse - element by such an excessive current.

2. Clause 4.15.6.3
That clause refers to protection by thermal overload devices and refers to devices complying with AS1023.

3. Clause 2.4.3.4
That clause refers to the protection of motors against short-time overload by fuses. It stipulates the fuse ratings required for different types of motors.

4. Clause 4.15.3
That clause deals with the function, rating, location and marking of isolating switches controlling motors and their ancillary equipment.

5. Main requirements: adequate enclosures; adequate insulating materials; ventilation as necessary; inclusion of anti-condensation heaters.

6. Any three of these following:
   - reduction to disruption of neighbouring consumers' supply
   - control of motor starting torque
   - control of motor acceleration rate
   - reduction in mechanical stress placed upon motor and drive
   - reduction in motor heating
   - less transients placed on supply lines
   - less stress placed upon supply authority's equipment.

7. Any three of these following:
   - DOL starter
   - star-delta starter
   - primary resistance starter
   - auto-transformer starter
   - electronic (soft-start) starter
   - secondary resistance starter.

8. Failsafe operation.

9. Locked rotor test.

10. 500 A

11. 197A

12. Reduce starting current and starting torque.

13. Non-automatic restart function and fail-safe operation.

14. 4

15. Latching contact.

16. Open circuited contactor coil.

Section 5

1. (a) 1/3 x I_{DOL}
   (b) depending on resistance value (normally 60-70% x I_{DOL})
   (c) $(65\%)^2$ x I_{DOL}

2. (a) ⅓ x T_{DOL}
   (b) Torque ∝ Voltage ^{2}
   (c) $(65\%)^2$ x I_{DOL}

3. *Advantages*
   relatively low cost
   good torque/current performance
   small-compact.
   available in a range of kW sizes
   easily installed

   Disadvantages
   restricted to low inertia loads
   6 terminal motor required
   speed falls in change over with transient current at transition
   problems can easily arise from incorrect connection

4. *Advantages*
   simple control circuit
   cost effective
   allows for runup without supply break
   allows for stepped resistors
   three wire connection to the motor.

   Disadvantages
   wasteful of power due to heat from resistors
   current/torque relationship is poor
   resistors are physically large

5. *Advantages*
   line current to starting torque optimal
   adjustable tapping
   may start high inertia loads
   un-interrupted supply during start. with Korndorfer method
   less wasteful of power than primary resistance

   Disadvantages
   expensive auto-transformers
   auto-transformers must be matched
   physically large and heavy

6. (a) fans, small pumps.
   (b) large water pumps, low starting torque applications
   (c) high power motor starting , high inertia applications.

7. Less sparking occurs at the contacts.

8. NTC characteristic

9. 6

10. $\frac{1}{\sqrt{3}}$

11. In series with the stator windings

12. Starter resistance is gradually decreased.

13. 33%.

14. 33%.

15. It is wasteful of power.

16. May be used on high inertia loads.

17. 5 and 4 respectively.

18. Stay in star configuration.

19. Interlock contact.

20. Coil KM1 energises first.

21. Coil KM2 energises.

22. Short circuit the resistors.

23. A mechanical interlock.

24. T1

25. Run with reduced torque.

Section 6

1.
- three-phase half controller
- three-phase full controller

2.

Advantages	*Disadvantages*
Adjustable starting voltage.	Higher cost
Adjustable acceleration time.	Complex circuitry.
Adjustable deceleration time.	

3. Slip ring induction motors (wound rotor).

4. Line current is approximately 2 x $I_{F/L}$
Motor torque can be maintained at maximum value

5. *Advantages*
Maximum torque is maintained.
Speed control is available
Low starting current

Disadvantages
Increased cost of installation
Suitable for only one type of of motor

6. *Electronic starters.*
½ controller - 7.5 kW to 284 kW motors.
Full controllers - motors over 285 kW.

Secondary resistance starters
High inertia loads

7. Adjustable starting voltage and adjustable starting time.

8. Fully controlled AC controller.

9. Controlling the trigger angle of the thyristor.

10. Pumping applications, traction drives.

11. Produce radio frequency interference.

12. Low line current and high torque at start.

13. High inertia loads.

14. 3

15. KM1

16. Coil KA1 will drop out when the start button is released.

Section 7

1. (i) plug braking
(ii) dynamic braking
(iii) regenerative braking
(iv) eddy current braking
(v) mechanical braking.

2. Resistors are used to reduce braking current.

3. DC voltage is applied to the stator.

4.

	Advantages	*Disadvantages*
(a)	high braking force low cost	zero speed switch problems strain on coupling
(b)	controlled braking full braking is achieved	requires two voltage sources mechanical brake required

(c)	▪ controls overspeed ▪ energy returned to the source	▪ cannot stop the motor ▪ cannot slow the motor below synch speed
(d)	low cost of installation prevents creeping.	high maintenance required brake relining required.

5. The brake is applied when the power is off, ie. power is required to release the brake.

6. Creeping is prevented by using mechanical braking.

7. To reverse rotation, change over any two phases to the motor starter.

8. Operate controls to disconnect the motor supply.

9. More than DOL starting current.

10. Regenerative braking.

11. An automatic mechanical braking function to protect against loss of supply.

12. Swap two of the supply lines to the motor.

13. Two types of voltage supply are required.

14. L1 and L3.

15. A mechanical interlock.

16. No effect on control circuit.

Section 8

1. ▪ change the motor supply frequency
   ▪ change the number of stator poles

2. Artificial poles formed between the mainpoles.
   By changing the main poles to all north or south poles.

3. ▪ controlled rectifier/inverter
   ▪ rectifier/inverter
   ▪ rectifier/chopper/inverter.

4. By changing the slip speed by introducing rotor resistance.

5. Winding machines, package machines, table rollers, pumps etc.

6. *Advantages*
compact
good speed control
easy to interface

Disadvantages
high cost
heating at low speeds

7.
- eddy current drive
- fluid couplings.

8. Two speeds for a single wound motor.

9. Both three-phase and single phase motors.

10. Increased with the frequency increase for speeds up to rated speed.

11. Separate force draught cooling.

12. Slow down.

13. Chopper.

14. Motor overheating.

Section 9

1.
- short duration
- long duration
- locked rotor

2. Short circuit and excessive loading.

3.
- continuous
- diminishing

4.
- in line - bimetallic strip operation
- thermistor

5. In series with the motor windings.

6. *advantages*
- fast operating
- high breaking capacity
- easy to replace
- large range.

7. See SAA wiring rules AS 3000 0 . 5 . 51.

8.
- dashpot
- variable time
- instantaneous trip.

9.
- overload protection for DC motors and large AC motors
- overload protection
- short circuit protection.

10. Low voltage will cause the motor to overheat and control elements may be sluggish.

11. No volt coils will disconnect the motor if the voltage falls below a preset value.

12. Overvoltage will cause heating of the motor and control coils together with increased power consumption.

13.
- increased heating of protective devices
- increased heating of the motor
- lower life span of moving parts.

14. See SAA wiring rules AS 3000 Section 6.

15. Detect abnormal motor temperature and disconnect the motor.

16. Only in-line overloads can have their current setting altered.

17. Faster to a larger overload current than to a small overload current.

18. A PTC thermistor.

19. Some overloads are intentional.

20. In series with the motor windings.

21. Inverse time characteristic.

22. The full load current of the motor.

23. Not provide effective protection.

24. Rapid tripping of the motor overload protection.

25. The motor load partially seized.

26. Normally closed and connected in series with the control circuit.

27. Not provide effective protection.

28. Reflect the thermal characteristics of the motor.

29. Control accessories have a shorter life span.

30. Slightly exceeding the starting current of the motor.

31. Is capital cost intensive to install.

32. 57.7 A.

Sample theory test 1

1. The magnetic field of a three phase induction motor rotates at: *(tick the correct box)*

   - ☐ slip speed
   - ☐ rotor speed
   - ☐ synchronous speed
   - ☐ synchronous speed - slip speed.

2. The rotating magnetic field of a three phase induction motor rotates at a speed governed by: *(tick the correct box)*

   - ☐ supply frequency and the number of stator poles
   - ☐ supply frequency and rotor speed
   - ☐ the number of stator poles and the motor type
   - ☐ rotor speed and the slip speed.

3. The magnitude of the flux produced by a three phase field system is: *(tick the correct box)*

   - ☐ 0.5 x that produced by a single phase winding
   - ☐ 1.0 x that produced by a single phase winding
   - ☐ 1.5 x that produced by a single phase winding
   - ☐ 1.73 x that produced by a single phase winding.

4. The direction of rotation of a three phase induction motor is dependent on supply: *(tick the correct box)*

   - ☐ voltage
   - ☐ phase sequence
   - ☐ frequency
   - ☐ current.

5. The rotor field of an induction motor is due to: *(tick the correct box)*

   - ☐ electromagnetic induction
   - ☐ rotor resistance
   - ☐ DC excitation
   - ☐ rotor reactance.

6. The slip speed of an induction motor is defined as: (*tick the correct box)*

- ☐ synchronous speed over rotor speed
- ☐ rotor speed over synchronous speed
- ☐ rotor speed minus synchronous speed
- ☐ synchronous speed minus rotor speed.

7. Interchanging any two slip ring connections of a wound rotor would: *(tick the correct box)*

- ☐ prevent the motor from operating
- ☐ cause the motor to overload
- ☐ have no effect on the motor operation
- ☐ reverse the rotation of the motor.

8. After carrying out an insulation test between each of the stator windings and earth, the motor would pass if all test result were: *(tick the correct box)*

- ☐ greater than 1 megohm
- ☐ less than 2 ohms
- ☐ between 2 ohms and 10 kΩ
- ☐ between 10 kΩ and 1 megohm.

9. The typical phase resistance of a stator winding for an induction motor would be: *(tick the correct box)*

- ☐ 10 to 100 ohms
- ☐ 100 to 1000 ohms
- ☐ greater than 1 megohm
- ☐ almost zero ohms.

10. The air gap between the rotor and the stator core is typically *(tick the correct box)*

- ☐ 5.0 mm
- ☐ 0.05 mm
- ☐ 0.5 mm
- ☐ 50 mm.

11. To reverse the direction of rotation of a squirrel cage motor you would: *(tick the correct box)*
    - ☐ disconnect and reverse the slip ring connections
    - ☐ interchange any two supply lead connections
    - ☐ change the delta connected stator winding to a star connection
    - ☐ replace the squirrel cage rotor with a wound rotor.

12. The rotor winding of a wound rotor induction motor is usually connected in: *(tick the correct box)*
    - ☐ parallel
    - ☐ delta
    - ☐ star
    - ☐ series.

13. The stator core is laminated to: *(tick the correct box)*
    - ☐ reduce eddy current loss
    - ☐ improve starting torque
    - ☐ provide silent running
    - ☐ reduce hysteresis loss.

14. Rotor bars are usually made from: *(tick the correct box)*
    - ☐ carbon or copper
    - ☐ steel or copper
    - ☐ steel or aluminium
    - ☐ copper or aluminium.

15. To improve starting torque and to reduce operation noise rotor bars are: *(tick the correct box)*
    - ☐ cast aluminium
    - ☐ star connected
    - ☐ the same number as the stator slots
    - ☐ skewed with respect to the stator slots.

16. Calculate the slip speed of a two pole 50 Hz three phase induction motor operating with a rotor speed of 2925 rpm.

17. Calculate the speed of rotation of the rotating magnetic filed of a four pole induction motor when connected to a 50 Hz supply.

18. If an induction motor operates with a percentage slip of 3%, and if the synchronous speed of the RMF is 1000 rpm, calculate the actual rotor speed.

19. If a 50 Hz induction motor operates with a rotor frequency of 2 Hz, calculate the percentage slip of the motor.

20. Calculate the supply frequency which would cause the rotating magnetic field of an eight pole induction motor to rotate at a synchronous speed of 1500 rpm.

21. The induction motor component which houses the three phase AC winding is the: *(tick the correct box)*

- ☐ rotor
- ☐ squirrel cage
- ☐ end shield
- ☐ stator.

22. The induction motor component which supports the rotational part of the motor is the: *(tick the correct box)*

- ☐ squirrel cage
- ☐ end shield
- ☐ stator
- ☐ rotor.

23. The induction motor component which produces the rotating magnetic field is the: *(tick the correct box)*

- ☐ stator
- ☐ squirrel cage
- ☐ end shield
- ☐ frame.

24. The stator core is laminated to: *(tick the correct box)*

- ☐ reduce eddy current losses
- ☐ reduce hysteresis losses
- ☐ increase ventilation
- ☐ reduce weight.

25. A rotor of a three phase induction motor is fitted with slip rings to allow the connection of: *(tick the correct box)*

- ☐ three phase supply
- ☐ stator windings
- ☐ DC excitation
- ☐ external resistances.

26. Squirrel cage three phase induction motors generally have: *(tick thecorrect box)*

- ☐ low starting torque and low starting current
- ☐ high starting torque and high starting current
- ☐ low starting torque and high starting current
- ☐ high starting torque and low starting current.

27. Dual cage rotor motors when compared to standard cage motors have: *(tick the correct box)*

- ☐ higher starting torque and lower full load slip
- ☐ higher starting torque and higher full load slip
- ☐ lower starting torque and lower full load slip
- ☐ lower starting torque and higher full load slip.

28. Wound rotor induction motors when compared to squirrel cage induction motors have: *(tick the correct box)*

- ☐ lower starting torque, with a higher full load speed
- ☐ higher starting torque, with a higher full load speed
- ☐ lower starting torque, with a lower full load speed
- ☐ higher starting torque, with a lower full load speed.

29. The main advantage of a wound rotor motor over a squirrel cage motor is: *(tick the correct box)*

- ☐ lower production cost
- ☐ more efficient speed control
- ☐ maximum torque can occur at starting
- ☐ wider range of speed control.

30. The main advantage of a squirrel cage machine over the wound rotor machine is: *(tick the correct box)*

- ☐ higher starting torque
- ☐ lower production cost
- ☐ higher full load slip
- ☐ lower starting currents.

31. A delta connected three phase induction motor has the following resistance measurements taken at the motor terminal block with the motor links still connected:

U_1 to V_1 = 5 ohms
V_1 to W_1 = 5 ohms
W_1 to U_1 = 10 ohms

The motor condition is: *(tick the correct box)*

- ☐ open circuit in U phase
- ☐ short circuit between U phase and V phase
- ☐ open circuit W phase
- ☐ motor tests OK.

32. An insulation resistance test is carried out on the terminals of a three phase induction motor with the connection links removed. The following results were recorded:

U_1 to frame = 2.0 M ohm	U_1 to V_1 = 1.95 M ohm
V_1 to frame = 1.9 M ohm	V_1 to W_1 = 0.75 M ohm
W_1 to frame = 2.1 M ohm	W_1 to U_1 = 2.0 M ohm

The motor condition is: *(tick the correct box)*

- ☐ acceptable due to high insulation resistance
- ☐ unacceptable due to low insulation resistance windings to frame
- ☐ unacceptable due to low insulation resistance between phase windings
- ☐ acceptable due to the low insulation resistance .

33. On inspection two phase windings of a star connected stator are found to be burnt out. The most likely condition to cause this fault would be: *(tick the correct box)*

- ☐ motor overload
- ☐ motor overspeeding
- ☐ single phasing
- ☐ overvoltage supply.

34. A delta connected three phase induction motor when started fails to rotate, but accelerates when manually rotated. The most probable condition responsible for this is: *(tick the correct box)*

- ☐ undervoltage supply
- ☐ a burnt out starting winding
- ☐ a phase winding reversal
- ☐ single phasing of the supply.

35. A three-phase squirrel cage induction motor star connected stator was found to have all phase windings burnt out. The most likely condition to cause this fault would be: *(tick the correct box)*

- ☐ motor overspeeding
- ☐ single phasing
- ☐ overvoltage supply
- ☐ motor overload.

Sample theory test 2

1. Limitation of starting currents taken by motors is detailed in: *(tick the correct box)*

   - ☐ supply authority local service rules
   - ☐ manufacturers' specifications
   - ☐ AS 3000 wiring rules book
   - ☐ local council health and building regulations.

2. The rating of an isolating switch must be: *(tick the correct box)*

   - ☐ equal to the full load current for AC motors
   - ☐ 4 times the full load current for AC motors
   - ☐ 6 times the full load current for AC motors
   - ☐ 8 times the full load current for AC motors.

3. If a motor incorporated an anti-condensation heater, the heater: *(tick the correct box)*

   - ☐ must be isolated when the motor is isolated
   - ☐ may be ignored for isolation purposes
   - ☐ must be disconnected when the motor is isolated
   - ☐ must be isolated after the motor being disconnected.

4. An installation consists of 2 x 11 kW three phase squirrel cage induction motors which only run when an operator is in attendance and 3 x 18.5 kW three phase motors which operate unattended. Which of the following statements is correct? *(tick the correct box)*

   - ☐ the 11 kW motors do not require overtemperature protection
   - ☐ the isolating switches adjacent to the motors must be capable of being locked in the off position
   - ☐ the isolating switches for the 18.5 kW motors must operate in both power and control circuits
   - ☐ the control switch for each motor must be rated at 10 times loaded rotor current.

5. In relation to the installation described in Question 4, would starting current limitation be applied to the 11 kW squirrel cage induction motor if the motor takes a current of 126 amperes when started DOL? *(tick the correct box)*

- ☐ yes, at all times
- ☐ no
- ☐ yes, only when operator attended
- ☐ depends on the supply authorities service rules.

6. The type of starter that requires 6 conductors between the starter and the motor is the: *(tick the correct box)*

- ☐ star-delta starter
- ☐ primary resistance starter
- ☐ reversing starter
- ☐ auto-transformer starter.

7. When starting a motor using a star-delta starter, the starting voltage applied to each starter winding would be: *(tick the correct box)*

- ☐ $\frac{1}{3}$ of the line voltage
- ☐ $\sqrt{3}$ of the line voltage
- ☐ $\frac{1}{\sqrt{3}}$ of the line voltage
- ☐ $\frac{1}{2}$ of the line voltage.

8. In many auto-transformer starters, the transition from the 'start' to the 'run' connection is accomplished without the need to disconnect the supply from the motor. This method of operation is known as: *(tick the correct box)*

- ☐ kemmis connection
- ☐ open delta transition
- ☐ korndorfer connection
- ☐ open circuit transition.

9. In a multi-step secondary resistance motor starter, as each step is completed, the resistors in the rotor circuit are: *(tick the correct box)*

- ☐ reconnected in series with the motor
- ☐ short circuited
- ☐ reconnected in parallel with the rotor
- ☐ open circuited.

10. The star and delta contactors in an automatic star-delta starter should be both mechanically and electrically interlocked to prevent: *(tick the correct box)*

- ☐ motor hunting
- ☐ overtemperature conditions
- ☐ simultaneous closing of the contactors
- ☐ overspeeding of the motor.

11. With regard to primary resistance starters, the types of material used in fluid resistors must exhibit a: *(tick the correct box)*

- ☐ NTC characteristic
- ☐ PTC characteristic
- ☐ ZTC characteristic
- ☐ CTC characteristic.

12. One disadvantage of using a star-delta starter is: *(tick the correct box)*

- ☐ the motor may be started with load
- ☐ more sparking occurs at the contacts
- ☐ it allows the motor to run up to speed without a break in the supply
- ☐ a transient occurs when switching from star to delta.

13. An application for a secondary resistance is: *(tick the correct box)*

- ☐ to start squirrel cage motors
- ☐ to start slip ring motors
- ☐ to start cage motors
- ☐ to start dual rotor motors.

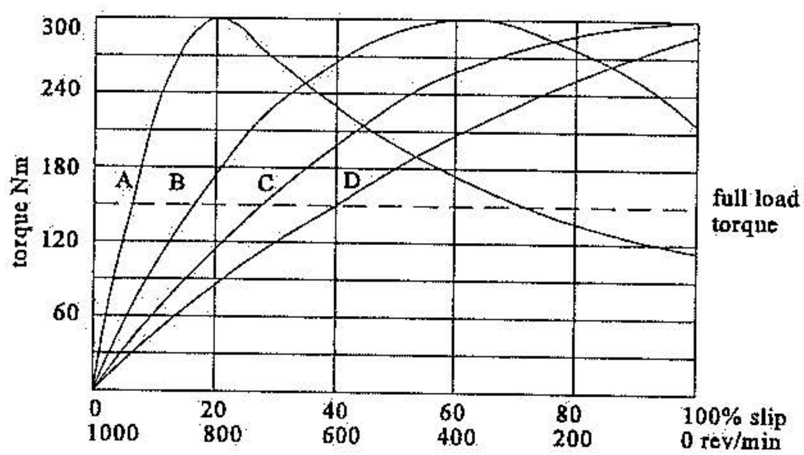
14. The starter providing the twin benefits of reduced starting current and increased starting torque is the: *(tick the correct box)*

- ☐ auto-transformer starter
- ☐ star/delta starter
- ☐ primary resistance starter
- ☐ secondary resistance starter.

15. A disadvantage of limiting the current when starting a squirrel cage three-phase induction motor is: *(tick the correct box)*

- ☐ less mechanical force exerted on the motor windings
- ☐ steadier acceleration of the connected load
- ☐ less disturbance to the supply lines
- ☐ a reduction in starting torque.

Questions 16 to 20 are related to the following characteristic curves for a three phase, 50 Hz slip ring induction motor



16. Which curve best suits maximum starting torque requirements?

____

17. If the standstill rotor reactance is 1.4 ohms, what would be the resistance of the rotor circuit to give maximum starting torque?

____

18. What is the value of breakdown torque for this motor?

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19. What is the starting torque when no resistance is added to the rotor circuit?

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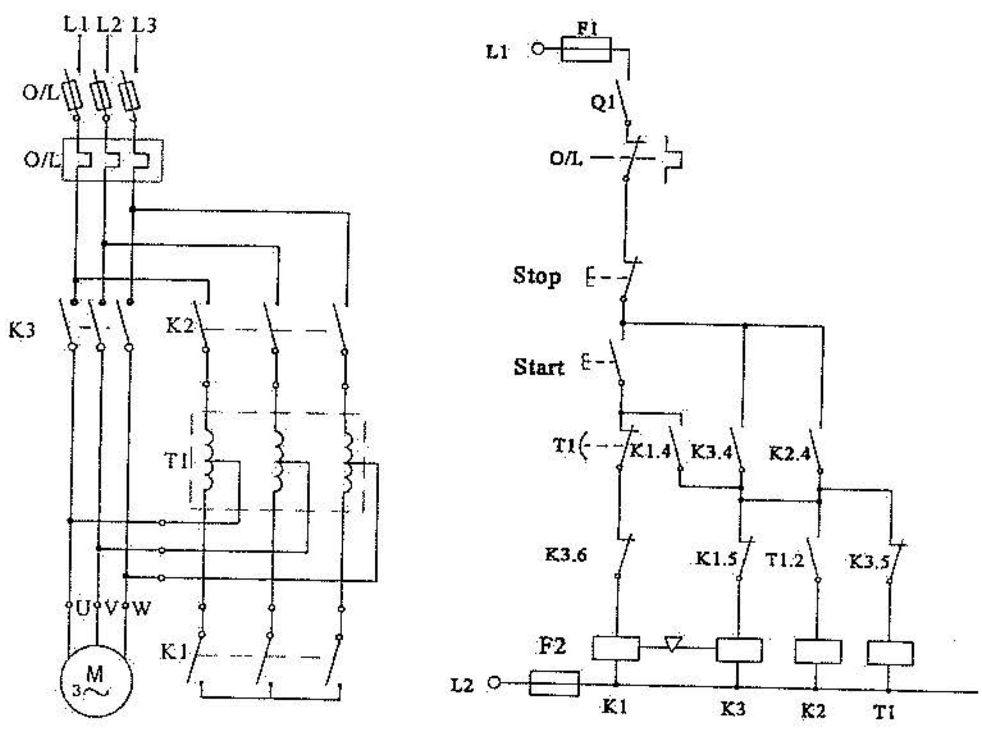
20. What is the approximate percent slip for curve B at full load?

Questions 21 - 25 refer to the AC motor starting circuit shown below.



Power circuit *Control circuit*

21. Name the type of starting circuit shown.

---

22. What will be the effect on the motor if time delay contact T1 does not operate?

____

23. What is the purpose of contactors K1 and K2?

____

24. What will be the effect on the motor if the K1-5 contact in series with the K3 coil fails to operate?

____

25. What does the triangle symbol between coils K1 and K3 indicate.?

____

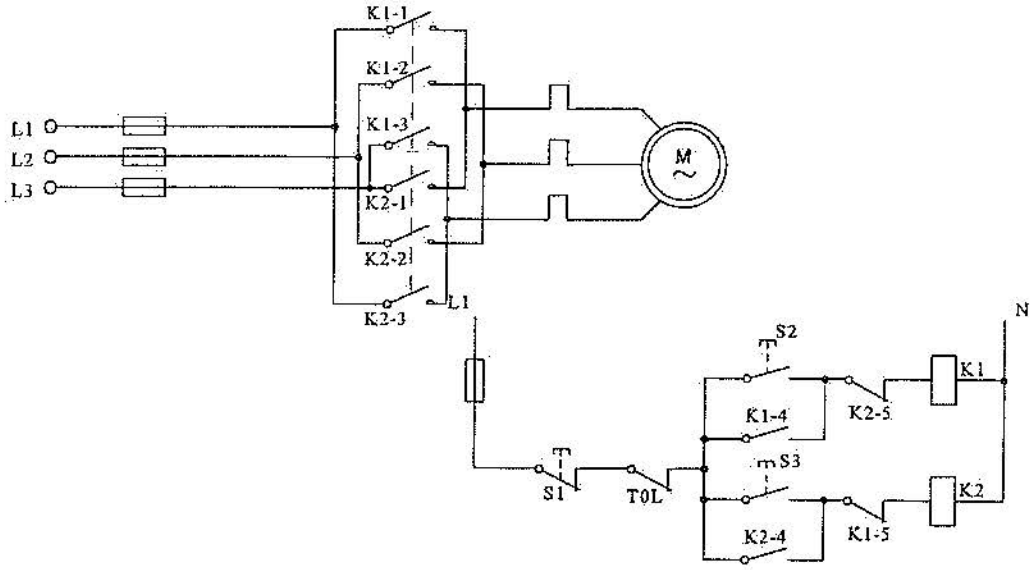
26. Regenerative braking of a AC squirrel cage induction motor is used to:
(tick the correct box)

- ☐ stop the motor when the speed is above synchronous
- ☐ slow the motor when the speed is below synchronous
- ☐ stop the motor when the speed is below synchronous
- ☐ slow the motor when the speed is above synchronous.

27. A three phase slip ring induction motor may have its speed decreased by:
(tick the correct box)

- ☐ adding resistance to the rotor circuit
- ☐ reducing the size of the cooling fan
- ☐ removing resistance from the rotor circuit
- ☐ changing the stator connections from star to delta.

Questions 28 - 30 refer to the AC motor circuit shown below.



28. The triangle symbol between contact K1 and K2 in the power circuit is a mechanical interlock, the purpose of this interlock is to: *(tick the correct box)*

- ☐ prevent phase to phase short circuits
- ☐ allow K2 to energise first
- ☐ allow K1 to energise first
- ☐ prevent phase to earth short circuits.

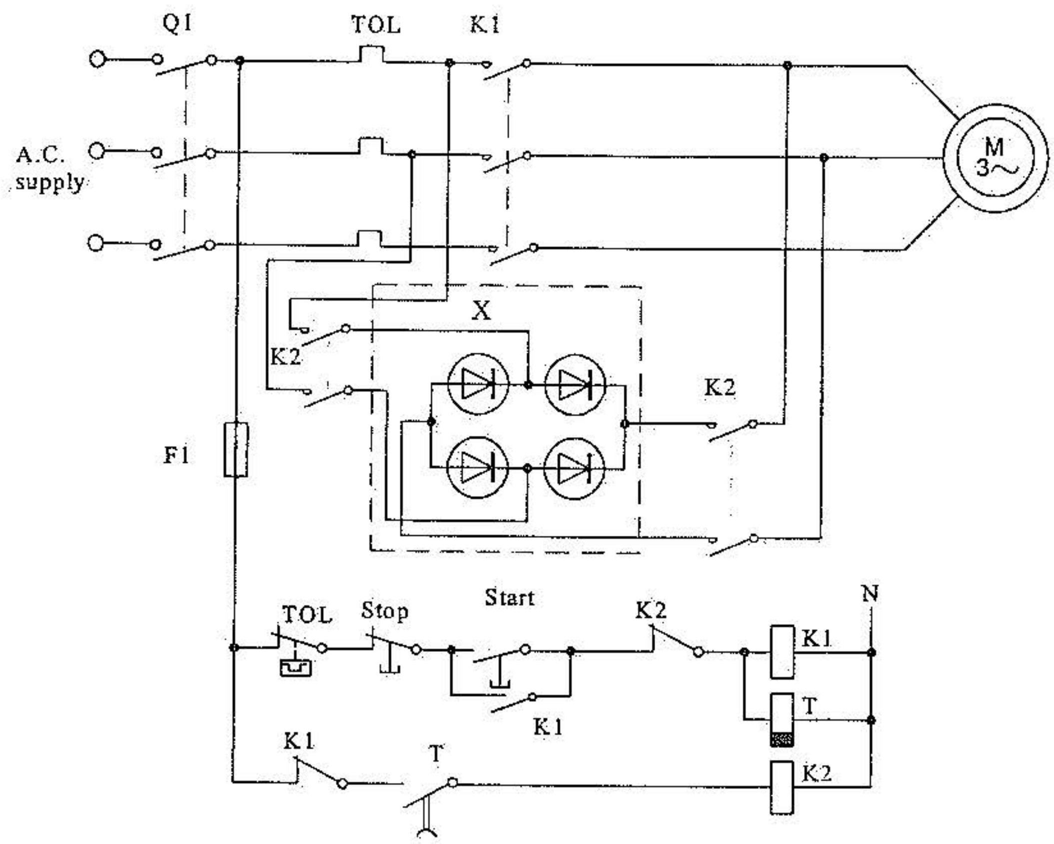
29. Using a sequence of events technique, if coil K2 is energised, what happens in the control circuit if pushbutton S1 is operated? *(tick the correct box)*

- ☐ coil K1 energises after K2 de-energises
- ☐ no effect
- ☐ coil K1 energises
- ☐ coil K2 de-energises.

30. To reverse the direction of rotation of the three phase motor, the following takes place: *(tick the correct box)*

- ☐ L1 and L3 are swapped
- ☐ L1 and L2 are swapped
- ☐ L1, L2 and L2 are swapped
- ☐ L2 and L3 are swapped.

Questions 31 - 35 refer to the AC motor braking circuit shown below.



31. What type of braking is used in the above circuit?

32. State the purpose of the normally closed contacts K1 and K2.

33. What is the purpose of the device within the dotted box marked 'X'?

34. After the motor has been running for some time the stop pushbutton is operated. What is the condition of timer relay T, contactor K1 and contactor K2 immediately after the stop pushbotton is pressed?

T: ____________________

K1: ____________________

K2: ____________________

35. What is the function of the thermal relay (TOL)?

____

____

Sample practical test 1 - Part 1

Duration
30 minutes

Task
Test a three phase squirrel cage motor to determine if it is suitable for connection to the supply.

Procedure
1. Sketch the terminal block, terminals, links or wiring connections of the terminal block supplied.

2. Complete the following table by:

   (a) listing the motor tests you would need to conduct before connecting the motor to the supply

   (b) listing the appropriate test instrument used to perform each test

   (c) using the test instruments perform the tests identified and record the results

Motor test	*Test instrument*	*Results*

Assessment
Students will pass this test if they can:
- ☐ identify at least three tests
- ☐ identify the test instruments required
- ☐ record the results obtained.

Sample practical test 1 - Part 2

Duration

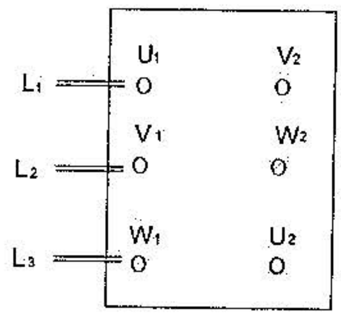
30 minutes

Task

Connect, run and reverse a three phase induction motor.

Procedure

1. On the diagram below draw the terminal block links required for the delta connection of the three phase induction motor.



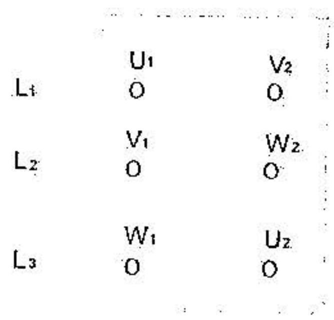
Motor terminal block

2. Connect the motor terminal block links for the delta connection of the motor.

3. Connect the motor to the supply and energise, and write the direction of rotation in the box.

   Direction of motor rotation: ______________________________

4. On the diagram below draw the connection changes required to reverse the motor.



Motor terminal block

5. Carry out the connection changes required to reverse the motor, energise and write the direction of rotation in the box.

   Direction of motor rotation: ______________________________

6. Ask the teacher to assess your work.

Sample practical test 2

Task

Connect the control and power circuit of the reduced voltage AC motor starter, then find introduced faults.

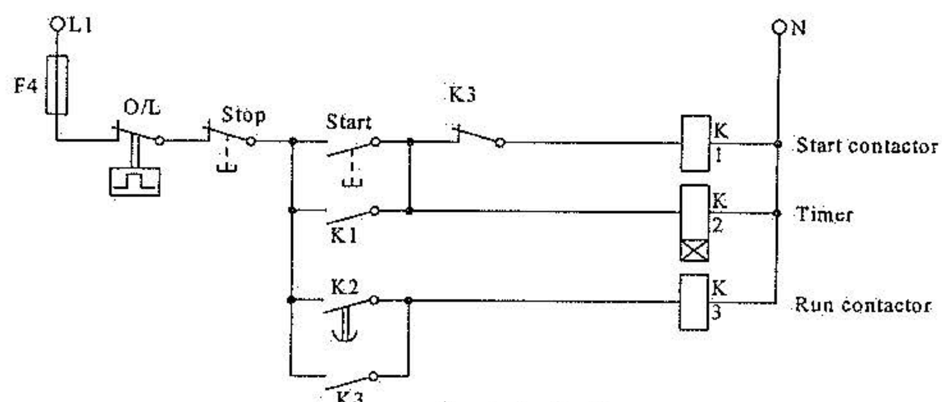
Equipment

- three phase 50 Hz supply
- three phase squirrel cage induction motor
- contactors (2)
- timer
- thermal overload
- stop/start pushbutton stations
- fuses (4)
- starting resistors (3)
- ammeter clamp-on type
- tachometer
- voltmeter
- connection leads.

Procedure

1. Connect up the AC motor starter control circuit as shown below using the equipment provided.

   DO NOT TURN THE POWER ON.



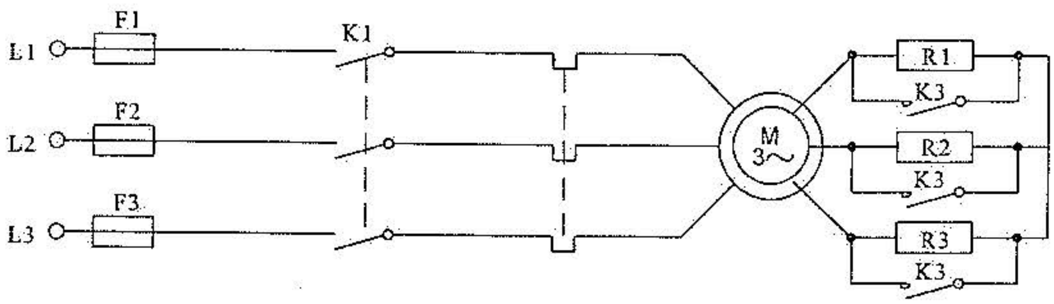
Control circuit

2. When you have finished the connections have the circuit checked by the teacher.

   Teacher safety check ☐

3. Connect up the AC motor starter power circuit as shown using the equipment provided.

DO NOT TURN THE POWER ON.



Power circuit

4. When you have finished the connections have the circuit checked by the teacher.

Teacher safety check ☐

5. Run the motor starter to ensure correct operational sequence and then measure and record the starting current of the motor and the no load speed of the motor:

I starting = __________ A

Speed N/L = __________ rpm.

6. When you have completed your readings, have them checked by the teacher.

7. Ask the teacher to introduce the first fault into your circuit.

8. Identify and list the type of fault found and the component/part of the circuit affected:

- Type of fault: ______________________________
- Component affected: ______________________________

9. When you have found the first fault, ask the teacher to check your results before proceeding to the second fault.

10. Ask the teacher to introduce the second fault in to your circuit.

11. Identify and list the type of fault found and the component part of the circuit affected.

    - Type of fault: ______________________________
    - Compound affected: ______________________________

12. When you have found the second fault, ask the teacher to check your results.

Answers to Sample Theory Tests

Theory Test 1

1. Synchronous speed.
2. Supply frequency and number of stator poles.
3. 1.5 x that produced by a single phase winding.
4. Phase sequence.
5. Electromagnetic induction.
6. Synchronous speed minus rotor speed.
7. Have no effect on the motor operation.
8. Greater than 1 megohm.
9. 10 to 100 ohms.
10. 0.5 mm.
11. Interchange any two supply lead connections.
12. Star.
13. Reduce eddy current loss.
14. Copper or aluminium.
15. Skewed with respect to the stator slots.
16. 75 rpm.
17. 1500 rpm.
18. 970 rpm.
19. 4%.
20. 100 Hz.
21. Stator.
22. Rotor.

23. Stator.

24. Reduce eddy current losses.

25. External resistances.

26. Low starting torque and high starting current.

27. Higher starting torque and higher full load slip.

28. Higher starting torque, with a lower full load speed.

29. Maximum torque can occur at starting.

30. Lower production cost.

31. Open circuit in U phase.

32. Unacceptable due to low insulation resistance between phase windings.

33. Single phasing.

34. Single phasing of the supply.

35. Motor overload.

Theory test 2

1. Supply authority local service rules.

2. Equal to the full load current for a.c. motors.

3. Must be isolated when the motor is isolated.

4. The isolating switches for the 18.5 kW motor must operate in both power and control circuits.

5. Depends on the supply authorities' service rules.

6. Star-delta starter.

7. $\frac{1}{\sqrt{3}}$ of the line voltage.

8. Korndorfer connection.

9. Short circuited.

10. Simultaneous closing of the contactors.

11. NTC characteristic.

12. A transient occurs when switching from star to delta.

13. To start slip ring motors.

14. Secondary resistance starter.

15. A reduction in starting torque.

16. Curve C.

17. 1.4 ohms.

18. 300 Nm.

19. 110 Nm (approx).

20. 15% (approx).

21. Auto-transformer.

22. Run at reduced speed.

23. Supply of reduced voltage to the motor.

24. It will run at reduced voltage.

25. Mechanical interlocking.

26. Slow the motor when the speed is above synchronous.

27. Adding resistance to the rotor circuit.

28. Prevent phase to phase short circuits.

29. No effect.

30. L1 and L3 are swapped.

31. Dynamic braking.

32. Interlock contacts.

33. It controls the braking effect.

34. T - de-energises
K1 - de-energises
K2 - energises.

35. TOL disconnects the motor in the event of a prolonged overload.