



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners cannot read answers written in cursive script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

1	Student Number	1708738
2	Title of Examination Paper	Electrical machines
3	Module Code	M6X00373
4	Date and Time of Examination	17-05-19
5	Examination Venue	IQ310
6	Seat Number	G069
7	Number of Answer Books handed in	

Complete, fold and seal
(see note 2 below)

SURNAME:

Thomas

FORENAME(S):

Adrian

List the numbers of the questions you have attempted	Office Use
1	10
2	5 1/2
3	9
4	2
5	2
6	8
7	8
Total	44 1/2

(Gweler yr ochr arall am y fersiwn Cymraeg)

89%

89%
1.4

1)

$$B_{\text{core}} = \frac{\Phi}{A} = \frac{560 \times 10^{-6}}{40 \times 10^{-3} \times 100 \times 10^{-3}} = 0.14 \text{ T}$$

from B/H curve $H = 375 \text{ A/m}$

$$\text{mmf}_{\text{core}} = H_{\text{core}} \times L_{\text{core}} = 375 \times 650 \times 10^{-3} = 243.75 \text{ A}\cdot\text{m}$$

$$H_{\text{gap}} = \frac{B_{\text{gap}}}{\mu_0} = \frac{0.14}{4\pi \times 10^{-7}} = 111408.4602$$

$$\text{mmf}_{\text{gap}} = H_{\text{gap}} \times L_{\text{gap}} = 111408.4602 \times 90 \times 10^{-3} = 10026.76141$$

$$I = \frac{\text{mmf}_{\text{total}}}{N} = \frac{243.75 + 10026.76141}{1200} = 8.559 \text{ A}$$

$$2a) \text{ emf} = NBA\omega \sin(\omega t) = 1600 \times 0.75 \times 0.0375 \times 50 \times 2 \times \pi = 14137.166 \text{ V}$$

~~or 14.137 kV~~

units? ✓

$$A = 250 \times 10^{-3} \times 150 \times 10^{-3} = 0.0375$$

$$\omega = 2\pi f = \frac{3000}{60} = 50$$

$$b) I = BA = 0.75 \times 0.0375 = 0.0281 \text{ W}$$

or 28.1 mW

3) Both motor types have similar construction in that they both have rotors and stators.

An induction motor uses a Squirrel Cage rotor, when power is applied to the stator a RMF begins to form which in turn induces magnetic flux in the rotor. This magnetic flux then begins to make the rotor turn. However with an induction motor the RMF of the stator & rotor should always have some slip, if the two fields were to become synchronous no torque would be produced since no flux would be induced until the rotor slowed to such a point where slip occurred.

A Synchronous motor locks together the rotor and stator magnetic fields by using a exciting DC voltage onto the rotor. The issues with this are this type of motor is not self starting since the inertia from the rotor takes the fields out of synchronous upon starting. This can be overcome by using a Squirrel Cage arrangement on the rotor until it is up to speed then the excitation voltage applied and the fields locked together.

Synchronous	Induction
not Self Starting	Self Starting
Constant Speed irrespective of load	Speed decreases with increased load
requires maintenance due to brushes on Slip ring	maintenance free

(9)

(a)

Synchronous
Complex to make
hard to control speed

work well on high
precision loads such
as rolling mills

induction
relatively simple
speed control possible

work well
on varying
speed loads.

$$4) P = 2\pi B I C \sin \theta$$

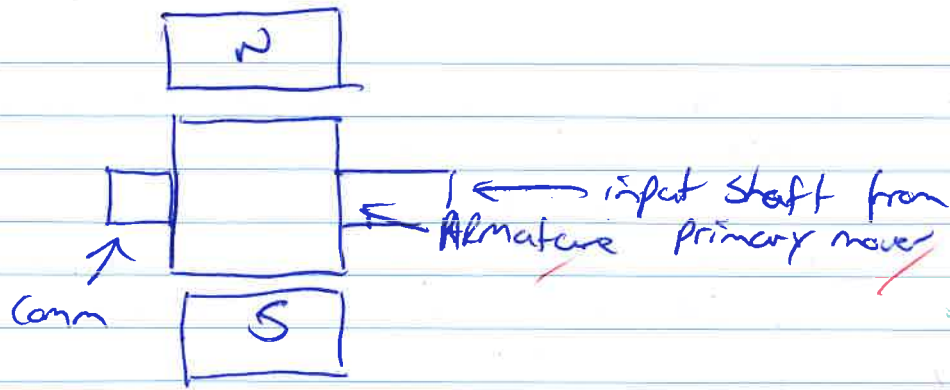
$$= 0.65 \times 48 \times 150 \times 10^{-3} = 3.24 \text{ W}$$

$$I = \frac{V}{R} = \frac{24}{0.5} = 48$$

$$5) \frac{50}{3} = 16.6$$

$$16.6 \times 60 = 1000 \text{ RPM}$$

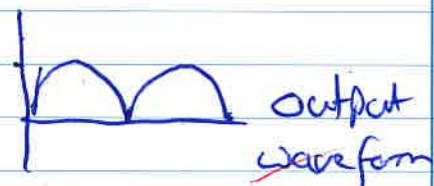
6)



When the armature is rotated by the primary mover via the input shaft a Rmf is created since the magnetic field is created via the field magnets located in the yoke of the generator.

When the Rmf is created a voltage is induced into the armature since it is cutting the magnetic flux generated by the field winding. This voltage is then collected via the Commutator and distributed out via the brushes.

In a true sense this machine produces an A.C output but by using a Slotted Commutator which is insulated in the centre via a strip such as mica a unidirectional current is output since the polarity of the voltage never reverses.

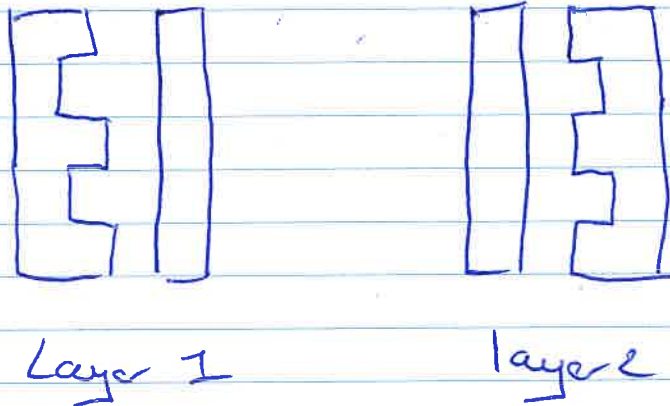


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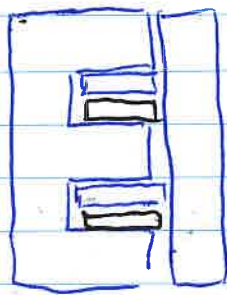
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7)

A shell type transformer also called an E I transformer is made up of multiple layers of E I strips layered on top of each other in opposite directions as below ✓



 Primary
 Secondary



Depending on the number of coils in either the primary or secondary the tx can be made to be a Step up or Step down ✓

if the Secondary has more coils the tx will be a Set up ✓

if the primary has more coils the tx will be a Step down ✓

The tx works as follows

When voltage power is applied to the primary winding ^{magnetic flux} ~~an~~ ~~emf~~ is generated, because both windings are mounted in the centre of the tx. This ~~emf~~ / flux will be transferred into the secondary windings ^{via the core} which will in turn generate a voltage. As previously mentioned depending on the number of coils in the winding will depend on the voltage out.

This type of tx is more efficient than a core type since less flux is lost due to the position of the coils.

In saying this, this tx will still suffer from the same losses as a core type i.e.

Heat loss from circulating eddy current ✓
Copper losses from the winding ✓
Iron losses from the core ✓

To try and limit the eddy current losses the core is made from steel laminates as previously mentioned ✓

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