



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 over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible 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.

Complete, fold and seal
(see note 2 below)

SURNAME: LAODEG

FORENAME(S): JOSEPH

1	Student Number	1708387
2	Title of Examination Paper	ELECTRICAL MACHINES
3	Module Code	M6X00373
4	Date and Time of Examination	17/05/2019 15:00
5	Examination Venue	1Q 310
6	Seat Number	9068
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	10 10
2	6 6
3	8 8
4	2 2
5	2 2
6	7 7
7	7 7
Total	42 42

(Gweler yr ochr arall am y fersiwn Cymraeg)

84 % 84%
f.l.

- ①. Cast iron.
 $B = 560 \mu\text{Wb}$
 $N = 1200$ turns.
 $L_1 = 650\text{mm}$
 $L_a = 90\text{mm}$
 $\text{CSA} = 40\text{mm} \times 100\text{mm}$

Assuming zero flux leakage and no fringing.

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

From b-h curve:

$$H_{\text{core}} = 310 \frac{\text{A.t}}{\text{m}}$$

$$\text{mmf}_{\text{core}} = H_{\text{core}} \times L_1 = 310 \times 650 \times 10^{-3} = 201.5 \text{ A.t}$$

$$\text{mmf}_{\text{gap}} = H_{\text{gap}} \times L_a.$$

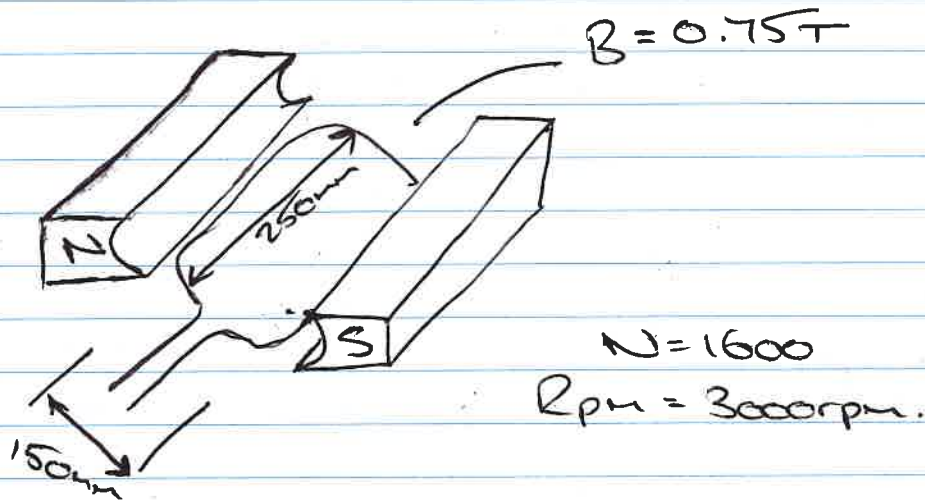
$$\text{where } H_{\text{gap}} = \frac{B_{\text{core}}}{\mu_0}$$

$$\therefore \text{mmf}_{\text{gap}} = \frac{0.14}{4\pi \times 10^{-7}} \times 90 \times 10^{-3} = 10026.76 \text{ A.t}$$

$$I = \frac{\text{mmf}_{\text{core}} + \text{mmf}_{\text{gap}}}{N} = \frac{201.5 + 10026.76}{1200}$$

$$I = 8.52 \text{ A}$$

(2)



a). Use $\text{emf} = NBA\omega [\sin(\omega t)]$

where $A = 150 \times 10^{-3} \times 250 \times 10^{-3} = 0.0375\text{ m}^2$
 $(37.5 \times 10^{-3}\text{ m}^2)$

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

$f = 50\text{ Hz}$

$\text{emf}_{\text{max}} = 1600 \times 0.75 \times 37.5 \times 10^{-3} \times 2 \times \pi \times 50$

$\text{emf}_{\text{max}} = 14137.17\text{ V}$

b). $\Phi_{\text{max}} = BA$ $\therefore \Phi_{\text{max}} = 0.75 \times 37.5 \times 10^{-3}$

$\Phi_{\text{max}} = 0.0281\text{ Wb}$ or 28.1 mWb

③ A 3 phase Induction motor consists of a stator and a rotor, in which the rotor turns inside the stator which is stationary. The rotor is surrounded by metal steel laminations. When AC current passes through the windings of the rotor, it produces a rotating magnetic field, which turns the motor. The motor operates by electricity being induced into the rotor rather than a separate supply.

A Synchronous motor is used for high precision applications where a constant speed is required. Unlike the Induction motor, a Synchronous motor constantly produces runs at the same speed irrespective of load. The rotor produces a constant magnetic field and the stator produces a rotating magnetic field. The Synchronous motor requires a separate 3 phase AC supply to operate.

A Comparison table follows.

Induction:

Synchronous.

③ Cheap and Squirrel
Cage are maintenance
free.

Expensive and
require frequent
maintenance.

Simple in Construction.

Complicated designs.

Self starting.

Not self starting.

Always runs at
less than
Synchronous, but never
equal.

Always runs at
Synchronous, irrespective
of load.

Speed control can
be achieved, but
difficult.

Speed control is
not possible.

P.f. is always
lagging, can't control P.f.

P.f. can be controlled
between lagging/leading.

Cannot be used
as Synchronous
Condenser.

Can be used as
Condenser to improve
P.f.

As load increases,
speed decreases.

As load increases,
load angle increases,
keeping Synchronous
speed.

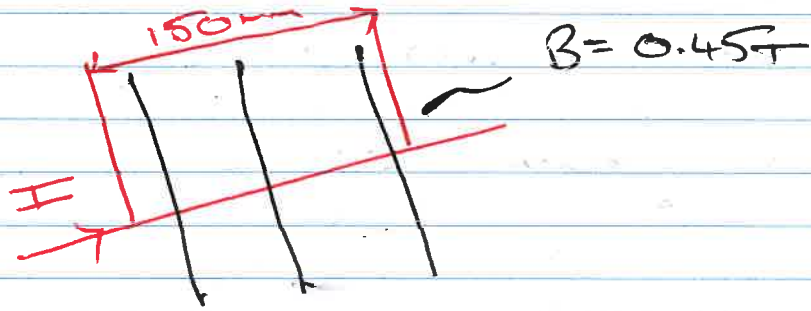
Phenomenon of
hunting is absent.

Hunting results from
sudden load
changes.

Does not require
a separate source,
Induced emf.

Requires a separate
DC source.

(4)



$$R = 0.5 \Omega$$

$$V = 24 \text{ V}$$

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

$$\therefore \text{ use } F = N B I L \sin \alpha$$

$$F = 1 \times 0.45 \times 48 \times 150 \times 10^{-3} \times \sin 90$$

$$F = \underline{3.24 \text{ N}}$$

(2)

2

⑤ 6 pole = 3 pole pairs.

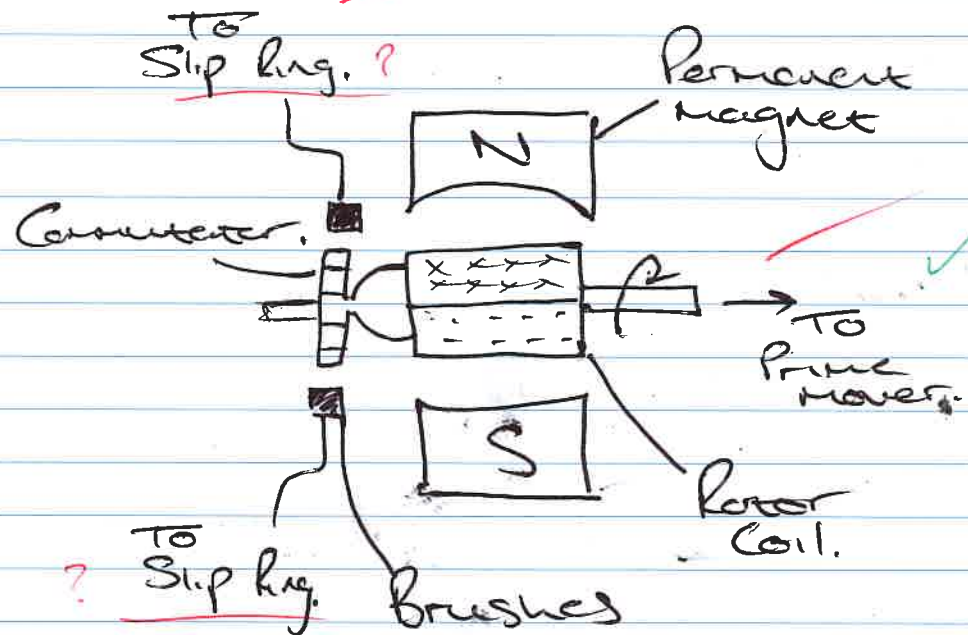
$$\therefore \frac{50}{3} \neq \frac{60}{3} = 20$$

$$\therefore \cancel{20 \times 60} \quad 20 \times 50 = \underline{1000 \text{ rpm}}$$

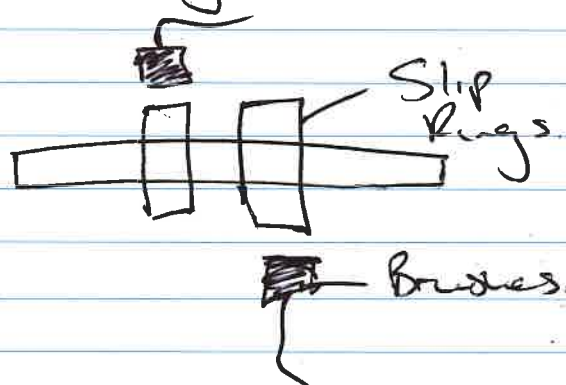
②

2

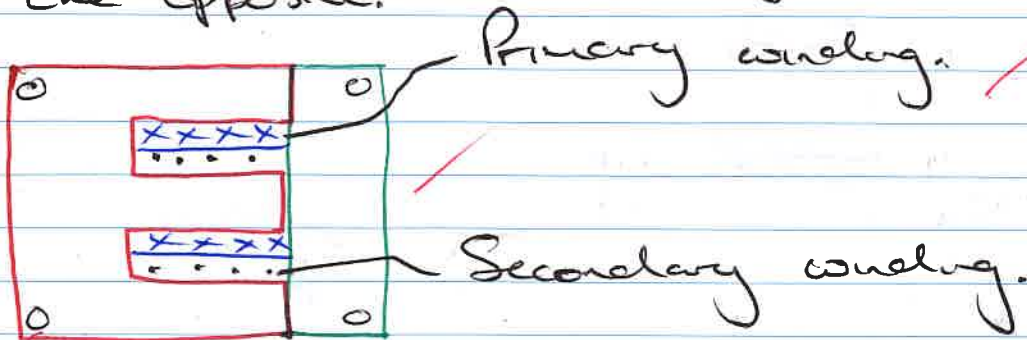
- ⑥. The Dynamo is required to generate DC voltage. The dynamo is basically a DC motor but backwards in operation. i.e. The shaft is rotated by a turbine or engine which creates a magnetic field in the rotor between 2 permanent magnets. A commutator is then used with the brushes connected to it to provide a DC output. However, the output will be rippled.



From the dynamo, the brushes also can connect to the other side Slip rings.



- ⑨. A Shell type single phase transformer can be manufactured in what is called I.E or E.I configuration. As below, is an E.I Configured, I.E is the opposite:



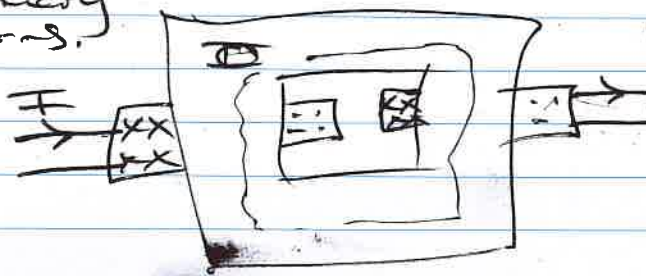
The Shell type single phase transformer would be used as maximum flux is produced due to the primary winding cutting directly through the secondary winding.

This way ~~also~~ also has less flux leakage. Due to the core being surrounding the windings, no magnetic flux is ~~lost~~ wasted, or very little.

The basic transformer works as:

Φ = magnetic flux.

N_p = Primary turns.

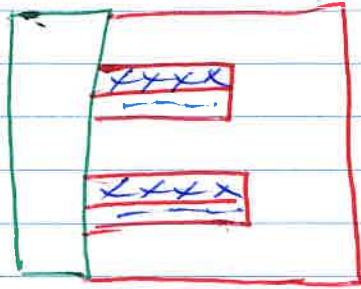


N_s = Secondary winding turns

$$N_p N_s = I_p I_s$$

$$I_{ref} = N \cdot I$$

The following is an IE
Configured side resferer!



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