COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)
SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE IV IN ELECTRICAL ENGINEERING-STAGE 5

EEE451 ELECTRICAL MACHINES

FINAL EXAMINATION – PENSTER 4, 2014

DATE/DAY: TBA **TIME**: TBA

ROOM: AS PER TIMETABLE

INSTRUCTIONS TO STUDENTS

1. You are allowed **10 minutes** extra **reading time** during which you are **NOT** to write.
2. Begin each SECTION on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with a string.
5. For all sheets of paper on which rough/draft work has been done, cross it through and ATTACH these to your answer scripts.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. Use of programmable calculator(s) is prohibited.
8. **ANSWER ALL QUESTIONS**
9. Show all working where necessary.
10. **ALWAYS CHECK YOUR WORK BEFORE YOU LEAVE THE EXAM ROOM**

SECTION A **(40 MARKS)**

1. Define transformer and also state its usefulness. (3 marks)

2. Three factors are required for the production of voltage in a transformer, state these three factors. (3 marks)

3. Specify the purpose of having tap changers on transformers? (4 marks)

4. What are the advisable colors to be used on a transformer tank and state the reason for using the indicated colors? (4 marks)

5. Define an ideal transformer? (3 marks)

6. State with aid of diagrams, the circuit connections of a three phase star-delta transformer. (3 marks)

7. List the names of four different types of three phase transformer cores. (4 marks)

8. State the relationship between the voltage and the number of turns of the two windings in a transformer. (3 marks)

9. State the three requirements for connecting a transformer in parallel and explain the effects of each. (9 marks)

10. State and specify the two different methods of cooling transformers. (4 marks)

SECTION B **(30 MARKS)**

1. Name two types of instrument transformers and state the reason for their use. (4 marks)

2. List three basic factors by which alternators are rated. (3 marks)

3. State the two main windings of an alternator, and specify where the two windings can be found in an alternator. (4 marks)

4. State the primary purpose of connecting two alternators in parallel. (2 marks)

5. Briefly describe what happens when two alternators with a fixed load and power factor has an increase in excitation. (4 marks)

6. The secondary circuit of a transformer must never be opened when current is flowing in the primary. Briefly explain what could happen if this occurs. (3 marks)

7. Draw and label clearly:
   (i) A basic alternator circuit (5 marks)
   (ii) A block diagram for an engine-driven standby alternator. (5 marks)

SECTION C **(30 MARKS)**

1. 240V is applied to the primary windings of a transformer having 1100 turns. If the secondary has 900 turns calculate the secondary voltage. (3 marks)

2. The maximum flux of a 50Hz transformer is 0.001Wb. If the primary is wound with 1080 turns, find the applied primary voltage and then calculate the number of turns required for a 15V secondary. (6 marks)

3. The 110V output of a transformer is applied to a 22Ω resistive circuit, causing 0.22Amps to flow in the primary winding. Calculate the primary voltage. (5 marks)

4. Determine the total copper loss of a transformer on full-load having secondary and primary currents of 100A and 20A respectively. (Winding resistance: secondary = 0.02Ω; primary = 0.05Ω) (6 marks)

5. At what speed would the governor of a 12 pole diesel driven alternator have to set to establish a frequency of 50Hz. (3 marks)

6. Determine the:
   (i) Generated phase voltage of a 50kVA, 50Hz alternator with 350 conductors per phase, flux = 0.0038Wb, distribution constant = 0.9, and coil pitch constant = 0.93. (3 marks)
   (ii) Voltage regulation if the output on load is 240V. (3 marks)

_____END PAPER_____

MARKING SCHEME

School:	Electrical & Electronic Engineering
Course:	Certificate IV in Electrical Engineering
Title:/Code:	**ELECTRICAL MACHINES / EEE451**
Stage/Penster/Year:	CTEEL 5 / Penster 4 / Year 2014
Date:	**TBA**
Examiner:	Sumendra Kumar

Model Answers and Marking Scheme

NOTE: Give a clear indication of answers expected and marks allocated for each part of a question.

SECTION A **(40 marks)**

1. Transformer is a device that can lower or raise the voltage current in an a.c circuit. It can be used to isolate circuits from each other and also enables the transmission of electrical energy over great distances and distribute it safely.
(3 marks)

2. - conductors (1 mark)
   - flux (1 mark)
   - And relative movement (1 mark)

3. Tap changers are installed in situations where they can compensate for variations in voltage. A rising or falling voltage at the load end of the line can be corrected by the action of a tap changer at the supply end.
(4 marks)

4. Polished metallic surfaces inhibit the removal of heat from transformer oil and casings.
Colors such as low sheen variations of black, green and grey enable the oil to run at lower temperatures.

(4 marks)

5. An ideal transformer is a transformer is one in which no losses occur and its core is infinitely permeable.
(3 marks)

6.

7. Three phase core type.
Three phase shell type
Three phase cruciform or stepped core
Three phase toroidal (4 marks)

8. The ratio of the primary and secondary voltages it equal to the ratio of the number of turns n the primary and the secondarywindings

Ie.

$$\frac{V1}{V2} = \frac{N1}{N2}$$ (3 marks)

9. (i) Equal voltage
A circulating current is set up between the transformers due to unequal voltage sources, therefore, the transformer becomes a burden on each other and are unable to supply power to an external load. (3 marks)

(ii) Same phase sequence
The east that can occur when two transformers which are connected in parallel and have different phase sequence, is a short circuit occurring between the lines and heavy circulating current flows which can cause damage to all sections of the instillations. (3 marks)

(iii) Phase voltage to be in step
Transformers must be compatible owing to possible phase shifts. When transformers in parallel are connected to different source supplies, phase shift occurring in one and not the other can damage both transformers and impose a heavy drain on the supply. (3 marks)

10. <u>Air cooling</u>
The air blast type of cooling is used on transformers where economy of space weight is required, or where oil cooling may be a fire hazard.
<u>Oil cooling</u>
The transformer tank is immersed in a tank of special transformer oil, providing as large a cooling surface area of the tank as possible.
(4 marks)

SECTION B **(30 marks)**

1. (i) voltage transformer/potential transformer (1 marks)
   (ii) Current transformer (1 marks)
   These transformers are used to set down the values of current and voltage to proportionate values that can be read by the metering equipment. (2 marks)

2. - frequency (1 mark)
   - Voltage (1 mark)
   - Current (1 mark)

3. - Three phase a.c winding – can be found on the stator (2 marks)
   - Winding carrying d.c – found on the rotor (2 marks)

4. To share connected load or to shift the load to the incoming machine without causing an interruption to the supply. (2 marks)

5, The machine with the greater excitation takes more of the load, but at a lower power factor and an increased kVAR output. The machine losing part of its load delivers less power but at a higher p.f and its kVAR becomes less. (4 marks)

6. When the secondary circuit is open circuited high current in the primary side causes flux in the core to reach peaks higher then normal which causes the core to be totally saturated. During this period very high voltage is induced across the open circuited secondary, an unsuspecting operator can easily receive a bad shock. (3 marks)

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7. (i) Basic alternator circuit
   (ii) A block diagram for an engine-driven standby alternator.
   (5 marks each)

Fig 11.2 from Electrical Principles for Trades pg 254

SECTION C **(30 MARKS)**

1. $V_2 = \frac{V1N2}{N1} = \frac{240 \times 900}{1100} = \underline{196.36 \text{ Volts}}$ (3 marks)

2. $V_1 = 4.44 N_1 f \emptyset_m$

$N_1 = 1080$ turns
$f = 50$ htz
$\emptyset_m = 0.001$ Wb
$V_1 = 4.44 \times 1080 \times 50 \times 0.001$
$= \underline{239.76 \text{ Volts}}$ (3 marks)

$V_2 = 15$ V

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$N_2 = \frac{N_1 V_2}{V_1} = \frac{1080 \times 15}{239.76} = 67.57$ turns (3 marks)

3. $I_2 = \frac{V_2}{R_2} = \frac{110}{22} = \underline{5 \text{ Amps}}$ (2 marks)

$$\frac{V_1}{V_2} = \frac{I_2}{I_1}$$

$V_1 = \frac{I_2}{I_1} \times V_2$

$= \frac{5(110)}{0.22}$

$V_1 = 2500$ V (3 marks)

4. Primary copper loss = I^2 X R_1

= $(20)^2$ X 0.05

= 20 Watts (2 marks)

Secondary copper loss = $(I_2)^2$ x R_2

= $(100)^2$ x 0.02

= 200 watts (2 marks)

Total Copper loss = Primary copper loss + Secondary Copper loss

= 20 + 200

= 220 Watts (2 marks)

5. $f = \frac{np}{120}$

$n = \frac{f(120)}{p}$

$= \frac{50(120)}{12}$

= 500 rpm (4 marks)

6. $Vg = 4.44 \text{Ø} f N_k d k_p$

= 4.44(0.0038)(50)(350)(0.9)(0.93)

= 500 rpm (3 marks)

$Vg = \frac{V_{NL} - V_{Fl}}{V_{FL}}$

$= \frac{247 - 240}{240}$ x 100

= 2.9 % (3 marks)