

CHUKA



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RESITS/SPECIAL EXAMINATIONS

**EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF
SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING**

EEENG 241: ELECTRICAL MACHINES 1

STREAM:

TIME: 2 HOURS

DAY/DATE: TUESDAY 29/8/2023

2.30P.M. – 4.30 P.M.

INSTRUCTIONS:

Answer question ONE and any other TWO questions

Do not write on the question paper

QUESTION ONE (30 MARKS)

- a) Determine the core area, the number of turns and the position of the tapping point for a 500-kVA, 50-Hz, single-phase, 6600/5000-V auto-transformer assuming the following approximate values : e.m.f. per turn 8 V. Maximum flux density 1.3 Wb/m².

[4 Marks]

- b) Explain why in mines applications oil cooled transformers aren't used

[3 Marks]

- c) Determine suitable number of poles for the design of a 1000kW, 500V DC machine.

[3 Marks]

- a) Differentiate between a squirrel cage type and slip Ring wound rotor. [4 Marks]

- d) Determine developed torque and shaft torque of 220-V, 4-pole series motor with 800 conductors wave connected supplying a load of 8.2 kW by taking 45 A from the mains. The flux per pole is 25 mWb and its armature circuit resistance is 0.6 Ω .

[4 Marks]

- e) Explain why transformers are rated in kVA. [2 Marks]
- f) A 3 phase, 4 pole induction motor operates from a supply whose frequency is 50 Hz. Calculate the frequency of the rotor current at standstill and the speed at which the magnetic field of the stator is rotating. [3 Marks]
- g) Outline THREE advantages of hysteresis motors. [4 Marks]
- h) List four desirable properties of insulating materials used in the design of electrical machines. [4 Marks]

QUESTION TWO (20 MARKS)

- a) A DC shunt motor having a full load efficiency (η) of 85 % takes a line current of 27A from 250 Volts mains on full load. If $R_a = 0.5\Omega$ and $R_f = 125\Omega$, find:
 - i. The constant losses, [7 Marks]
 - ii. load current for maximum efficiency [2 Marks]
 - iii. the maximum efficiency. [3 Marks]
- b) Explain two transformer classifications. [4 Marks]
- c) A 220-V three-phase six-pole 50 Hz induction motor is running at a slip of 3.5 percent. Find:
 - i). The speed of the magnetic fields in revolution per minute
 - ii). The speed of the rotor in revolutions per minute
 - iii). The slip speed of the rotor
 - iv). The rotor frequency in hertz

[4 Marks]

QUESTION THREE (20 MARKS)

- a) Find the mechanical power output at a slip of 0.005 of the 185-W, 4-pole, 110-V, 60-Hz single-phase induction motor, whose constants are given below:

$R_1=1.86\Omega$	$X_1=2.56\Omega$	$X_2=2.56\Omega$
$X_m=53.5\Omega$	$R_2=3.56\Omega$	

[14 Marks]

- b) Explain the term 'slip' as applied to three phase induction motors. [2marks]
- c) Describe two factors affecting the choice of the number of poles used in DC Machines. [4 Marks]

QUESTION FOUR (20 MARKS)

- b) The 2,300-volt primary winding of a 60-cycle transformer has 4,800 turns. has 1320 primary turns and 46 secondary Calculate:
- i). the mutual flux ϕ_m ; [2 Marks]
 - ii). the number of turns in the 230-volt secondary winding; [2 Marks]
 - iii). the maximum flux in the core of a 60-cycle transformer that turns is 3.76×10^6 maxwells. Also, calculate the primary and secondary induced voltages. [2 Marks]
- c) Distinguish between core and shell type transformers. [4 Marks]
- d) A 20-kva load is to be supplied at 500 v. An ideal step-up autotransformer is used to connect this load to a 400-v source. Find
- i). the voltage and current of the series winding, [2 Marks]
 - ii). the voltage and current of the common winding [2 Marks]
 - iii). the kva rating of this transformer if it were used as a two-winding transformer. [2 Marks]
- e) Describe two transformer cooling methods. [4 Marks]
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