



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**  
**FACULTY OF ENGINEERING**  
**DEPARTMENT OF ELECTRONIC ENGINEERING**  
**ELECTRICAL AND ELECTRONIC TECHNOLOGY**

**TEE 2114**

**Special Supplementary Examination August 2024**

This examination paper consists of 5 pages

Time Allowed : 3 hours  
Special Requirements : Graph paper  
Examiner's Name : Dr. L. Matindife  
External Examiners :

**INSTRUCTIONS TO CANDIDATES**

1. **Section-A** is compulsory with total **Forty** marks.
2. In **Section-B** attempt any **Three** questions out of **Four** questions each **Twenty** marks.
3. Start the answers for each question on a fresh page.
4. Marks will only be awarded for answers that **directly** relate to the questions asked
5. Take:  $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

**MARK ALLOCATION**

	QUESTION	MARKS
SECTION-A	1.	10
	2.	10
	3.	10
	4.	10
SECTION-B	5	20
	6	20
	7	20
	8	20
TOTAL	7	100

## SECTION A

### Question 1

For the magnetic circuit shown in Fig. 1 the flux in the right limb is 0.24 mWB and the number of turns wound on the central-limb is 1000.

Calculate

- (i) flux in the central limb, and [5]
- (ii) the required current. [5]

The magnetization curve for the core is given as below:

H (AT/m)	200	400	500	600	800	1060	1400
B (Nb/m <sup>2</sup> )	0.4	0.8	1.0	1.1	1.2	1.3	1.4

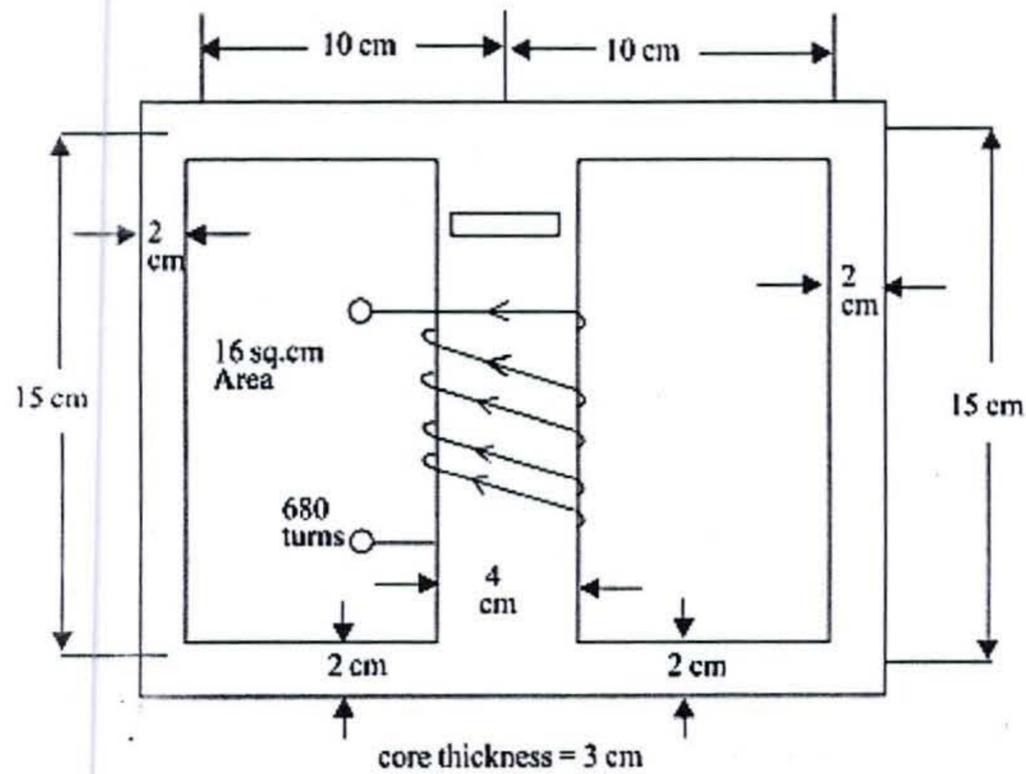


Fig. 1

### Question 2

In a three-phase four-wire system the line voltage is 415V and non-inductive loads of 10kW, 8kW, and 5kW are connected between the three line conductor as and the neutral .

- a) Sketch the circuit diagram for the connections. [2]
- b) Find the current in each conductor and in the neutral. [5]
- c) Draw a phasor diagram for the currents. [2]
- d) Find the current in the neutral conductor [1]

### Question 3

A 4-pole DC machine has an armature winding of radius 12.5cm and length 25cm. The poles cover 75% of the armature periphery. The armature winding consists of 33 coils each coil having 7 turns. The coils are accommodated in 33 slots. The average flux density under each pole is 0.75T.

If the armature is lap-wound determine

- i) the machine constant [2]
- ii) the generated voltage when the armature rotates at 1000rpm [3]
- iii) the current in the coil and developed torque if armature current is 400A [3]
- iv) the power developed by the armature [2]

### Question 4

- a) State TWO advantages and TWO disadvantages of the synchronous motor [2]
- b) Explain the term power factor correction and why is it important in factories? [3]
- c) Outline the procedure of synchronizing a generator to an infinite busbar [5]

## SECTION B

### Question 5

Three single-phase 50kVA, 2300/230V, 60Hz transformers are connected to form a three-phase 4000/230V transformer bank. The equivalent impedance of each transformer is  $0.12 + j0.016 \Omega$ . The three-phase transformer supplies a three-phase 120kVA, 230V, 0.85 lagging power factor load.

- 1) draw the schematic diagram showing the transformer connections [4]
- 2) determine the transformer winding currents [6]
- 3) determine the primary line-line voltage required [6]
- 4) determine the voltage regulation [4]

### Question 6

A DC motor rated at 12kW, 100V, 1000rpm is connected to a 100V dc supply and is operated as a DC shunt motor. The armature resistance is  $0.1\Omega$ , shunt field winding resistance is  $80\Omega$  and it has 1200 field turns per pole. The rated field current is 1A. the magnetization curve of the machine at 1000rpm is shown in Fig. 6. At no load condition, the motor runs at 1000rpm and the armature takes 6A. The armature resistance is  $0.1\Omega$  and field current is 0.99A. Find:

- a) Find the value of the resistance of the shunt field control rheostat. [4]
- b) Find the rotational losses at 1000rpm. [4]
- c) Find the speed, electromagnetic torque and efficiency of the motor when rated current flows in the armature. [6]
  - i. Consider that the air gap flux remains as that at no load.
  - ii. Consider that the air gap flux is reduced by 5% when rated current flows in the armature because of armature reaction.
- d) Find the starting torque if the starting armature current is limited to 150% of its rated value [6]
  - i. Neglect armature reaction

Consider the armature reaction equivalent current is 0.16A.

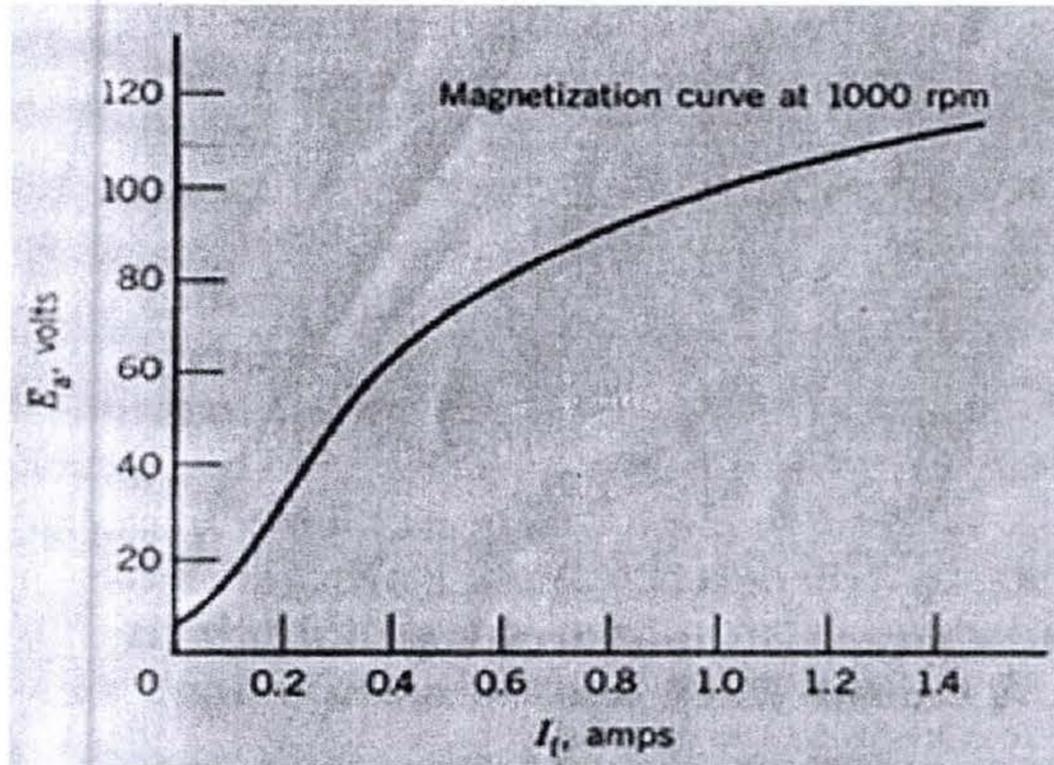


Fig. 6: Magnetization curve at 1000 rpm showing  $E_a$  volts against  $I_f$  amps.

**Question 7**

- a) Sketch and label the phasor diagram of a synchronous generator. [6]
- b) A 100kVA, 1200V, three phase alternator is star-connected. Its resistance per phase is  $0.12\Omega$  and its reactance is  $1.5\Omega$ . Find its voltage regulation if it supplies rated load at:
  - i) power factor of 1 [4]
  - ii) power factor of 0.9 lagging [5]
  - iii) power factor of 0.9 leading [5]

**Question 8**

- a) Show diagrammatically the essential features of a two-phase induction type a.c. servo-motor. [6]
- b) Explain how it can provide a positive braking torque. [4]
- i) Describe the principle of operation of a  $45^\circ$  Step single-stack variable-reluctance stepper motor. [8]
- ii) Why may it be necessary to have a multi-pole rotor for this stepper motor? [2]