الجامعة الوطنية
National University
Science & Technology للعلوم والتكنولوجيا
كلية عمان البحرية الدولية
International Maritime College Oman

ACADEMIC YEAR 2023 - 2024

Program	Year	Semester	Paper
PE	2	1	MAIN

MODULE NAME:	**ELECTRICAL MACHINES AND DRIVES**		
MODULE CODE:	**TEMD**	**EXAM DATE:**	**27-12-2023**
INSTRUCTOR's NAME:	**Ranjit V**	**DURATION:**	**2 hrs**

Questions to be answered on:	**Allowed tools:**	**Number of pages**
ü Space provided on the question paper	Pen, Pencil & Calculator	(Incl. cover page): **14**

Points of attention:

- For each question, the maximum earned points are mentioned between brackets at the end of each question.
- Write very clearly! Answers that are not readable are not marked and don't get points!
- Make sure your answers are written to the point.
- All answers should be written **in English.**
- Write all the answers in **blue or black pen only.**
- Use the **pencil** only for **diagrams & graphs.**
- Show all the calculation steps in the given space.
- When finished submit the question paper, together with the answer scripts and the signed cover page to the invigilator.
- Any cheating/copying may result in an instant failing of the examination.

STUDENT NAME:

STUDENT ID:

FINAL MARKS	
	40
	10

Number of answer scripts:……..…….. **Invigilator:**……..……..

Student's signature: …… **Time of receipt:**……..…..

INSTRUCTIONS

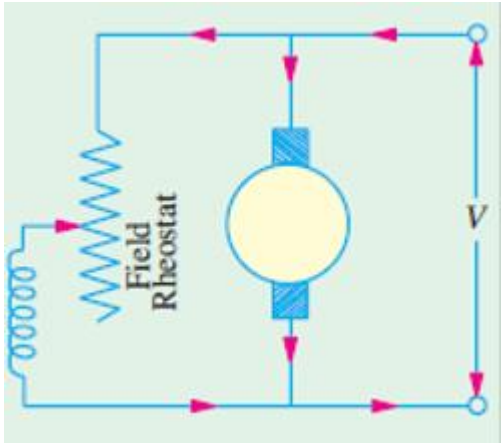
- *Express the **CORRECT** SI units for all the dimensional quantities or ½ **MARK** will be **deducted** from each **answer***

SECTION A

There are overall 8 questions in Section A. Answer all the questions in the space provided.
Each question carries two marks. **[8 × 2 = 16 marks]**

1. Differentiate between the shell and core construction of a transformer. Give any 2 points.

2. The below figures show one of the methods of controlling the speed of a DC motor.



(Daware, 2014)

Identify this method by which the speed of the motor can be controlled. Give one characteristic feature of this connection.

3. List out any two high-voltage and low-voltage deficiencies in electrical machines.

4. A single-phase 50 Hz transformer has 120 turns in the primary windings and 1000 in the secondary windings. The net cross-sectional area of the core is 200 cm^2. If the primary winding is connected to 240V, determine the maximum flux density in the core.

5. Usually, the transformer tank is filled with mineral oil. Explain, why a transformer tank is filled with mineral oil.

6. A 440-volt DC shunt motor has an armature resistance of 1.75 ohms, on load it takes an armature current of 50 A and runs at 1500 rpm. If the flux of the motor is reduced by 7.5% without changing the load torque, calculate the new speed of the motor.

7. One-fourth of the conservator drum is usually kept empty. Can you provide a suitable supporting reason for this statement?

8. Explain the fundamental principle of a single-phase transformer.

SECTION B

There are overall 4 questions in Section B. Answer any three questions in the space provided.
Each question carries 8 marks. [8 × 3 = 24 marks]

9. a) Differentiate between the Y and Δ connection in the winding of a three-phase transformer. Give any two points. **(2 marks)**

b) A single-phase transformer is rated at 100 kVA. The transformer has full-load copper losses of 650 W and iron losses of 500 W.

Determine the transformer efficiency at half-full load and 0.92 power factor. **(4 marks)**

c) Calculate the no-load voltage of the transformer having a regulation of 4.5 % at a full load voltage of 225V. **(2 marks)**

10. a) Compare the DC shunt and DC series motor based on construction and operation with a suitable circuit diagram. **(4 marks)**

b) Draw the block diagram for the variable frequency drive(VFD) speed control method for AC motors. Explain the main parts and describe their functions in detail. **(4 marks)**

11. a) Describe the various losses that reduce the efficiency of the transformer. Suggest suitable methods for reducing these losses. **(2 marks)**

b) A 1.1kV/440 V, Y - Δ connected three-phase transformer delivers 500 kVA on full load. Calculate

i) The turns ratio **(2 marks)**

ii) The secondary full-load line current (I_L) and Phase current (I_{ph}). **(2 marks)**

iii) The primary full-load line current (I_L) and Phase current (I_{ph}). **(2 marks)**

12. a) Describe the construction and principle of a three-phase transformer with the help of a neat and labelled diagram. **(4 marks)**

b) Discuss any 4 factors that affect the efficiency of the transformer. Also, suggest the causes and preventive methods to improve the efficiency of the transformer. **(4 marks)**

Formula Sheet

1. Synchronous Speed $N_s = \frac{120f}{P}$
2. $\%\ Slip = \frac{N_s - N_r}{N_s} \times 100$
3. $N_r = N_s\ (1 - s)$
4. $f_r = s \times f$
5. $P = \sqrt{3} \times V \times I \times \text{Cos}\ \emptyset$
6. $P = V \times I \times \text{Cos}\ \emptyset$
7. $E_p = 4.44\ f\ \emptyset_m N_p$
8. $E_s = 4.44\ f\ \emptyset_m N_s$
9. $\emptyset_m = B_m \times Area$
10. $V_L = \sqrt{3}\ V_{ph}$, $I_L = I_{ph}$
11. $V_L = V_{ph}$, $I_L = \sqrt{3}\ I_{ph}$
12. $Transformer\ Efficiency\ (\eta) = \frac{Output\ Power}{Input\ Power} \times 100$

$$Transformer\ Efficiency\ (\eta) = \frac{Input\ Power - losses}{Input\ Power} \times 100$$

$$\eta = \frac{Output\ Power}{Output\ Power + Losses} \times 100$$

13. The efficiency at any load is given by

$$\eta = \frac{(x \times full\ load\ kVA \times power\ factor)}{(x \times full\ load\ kVA \times power\ factor) + (W_i + x^2\ W_{Cu})} \times 100$$

14. $Total\ losses = (W_i + x^2\ W_{Cu})$
15. $W_{Cu} = I_L{}^2\ R$
16. $\%\ Regulation = \left(\frac{No\ load\ secondary\ voltage - Secondary\ voltage}{No\ load\ secondary\ voltage}\right) \times 100$

$$\%\ Regulation = \left(\frac{E_2 - V_2}{E_2}\right) \times 100$$

17. $Armature\ Back\ Emf\ E_b = \text{N}\ \emptyset$
18. $Back\ Emf\ E_b = \text{V-}\ I_a\ R_a$
19. $Torque\ T = \emptyset\ I_a$ Newton-Metre
20. $\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}} \times \frac{\emptyset_1}{\emptyset_2}$