T460(E)(M26)T

APRIL EXAMINATION

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

(11040343)

26 March 2014 (Y-Paper)
13:00–16:00

This question paper consists of 6 pages and 1 formula sheet of 3 pages.

Please turn over

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Read ALL the questions carefully.

3. Number the answers according to the numbering system used in this question paper.

4. Keep subsections of questions together, for example QUESTION 1. 1.1, 1.2, et cetera.

5. Rule off on completion of each question.

6. The correct information must be copied from the question paper and substituted for the correct symbol.

7. Sketches and diagrams must be done in pencil and must be neat, reasonably large and fully labelled.

8. Round off the answers to THREE decimal places after the comma.

9. Use the correct units for answers.

10. Write neatly and legibly to avoid being penalised for untidy and illegible work.

1.3 Pole pitch is the (metres, distance, displacement) between the centres of the poles.

1.4 (Wave-wound, Lap-wound, Armature winding) is for heavy-current machines.

1.5 It has its field windings connected in series with the armature (compound-connected, series-connected, self-excited-connected).

(5 x 2) **[10]**

QUESTION 2

2.1 Name TWO generators which are dependent on the excitation process in order to operate. Support the answer with TWO relevant sketches. (6)

2.2 State FOUR factors on which the magnitude of the induced EMF in a conductor depends. (4)

[10]

QUESTION 3

3.1 Draw neat, labelled schematic diagrams to explain how the direction of the following DC motors can be reversed.

3.1.1 Shunt motor

3.1.2 Compound motor

(2 x 2) (4)

3.2 What is the purpose of a starter resistor which is connected in series with the armature? (2)

3.3 A DC motor has a full-load current of 45 A and an armature resistance of 0,65 Ω. The supply voltage is 180 V.

Determine the back EMF in kV. (4)

[10]

4.1 Input power of the motor in kW (3)

4.2 Output power of the motor in kW (4)

4.3 The motor efficiency (3)
[10]

QUESTION 5

5.1 A resistor, an inductor and a capacitor are *each in turn* connected to a 220 V, 60 Hz supply (that is not in parallel or series).

Calculate the current flow in each of the following:

5.1.1 40 mH inductor (2)

5.1.2 130 μF capacitor (2)

5.1.3 70 Ω resistor (1)

5.2 If the components in QUESTION 5.1 are connected in parallel, determine:

5.2.1 The total current flowing in the circuit (3)

5.2.2 The circuit impedance (2)
[10]

6.4 The inductance value of the circuit (4)
[10]

QUESTION 7

7.1 An alternating voltage of 230 V at a frequency of 90 Hz is applied to a circuit consisting of a resistor of 12 Ω, an inductor of 0,02 H and a capacitor of 70 μF connected in series.

Determine the resonance frequency of the circuit. (6)

7.2 Name TWO disadvantages of a low power factor. (2)

7.3 Name TWO components that can be used to correct a low power factor. (2)
[10]

QUESTION 8

8.1 A single-phase transformer has 350 windings on the primary coil which is connected to a 210 V supply. The secondary voltage and current is 42 V and 8 A respectively.

Calculate the following:

8.1.1 The number of windings on the secondary side

8.1.2 The primary current

8.1.3 The rating of the transformer in VA
(3 x 2) (6)

8.2 State the dual purpose of the oil-immersed transformer. (2)

8.3 Name TWO iron losses that occur in the transformer. (2)
[10]

9.2 A moving-coil instrument gives a full-scale deflection if 25 mA flows through it. The resistance of the coil is 50 Ω.

Determine the following:

9.2.1 Voltage across the meter (1)

9.2.2 The resistance required to use the instrument as an ammeter for a 1 A current flow (3)

9.2.3 The series resistance required to use it as a voltmeter up to 12 V (3)
[10]

QUESTION 10

10.1 Name THREE configurations where a transistor is used as an amplifier. (3)

10.2 How many valence electrons does a P-type material have? (1)

10.3 State the main advantage of a cathode-ray oscilloscope as compared to other electrical measuring instruments. (2)

10.4 State ONE component which is used in the filtering circuit. (2)

10.5 Draw a truth table of an AND gate with TWO inputs logic. (2)
[10]

TOTAL: 100

3. $E = 2p\Phi \dfrac{ZN}{60C}$

4. $N = \dfrac{V}{K\Phi}$

5. $T = \dfrac{0{,}318\, I_a\, Zp\, \Phi}{C}$

6. $Efficiency/Rendement = \dfrac{VI}{VI + Ia^2 Ra + IsV + C} \times 100$

7. $Efficiency/Rendement = \dfrac{VI - (Ia^2 Ra + IsV + C) \times 100}{VI}$

8. $Efficiency/Rendement = \dfrac{2\pi N(W - S) \times r}{60\, VI} \times 100$

9. $Efficiency/Rendement = \sqrt{\dfrac{I_1}{I_1 + I_2}} \times 100$

10. $E = Blv$

11. $e = E_m Sin 2\pi ft$

12. $i = I_m Sin 2\pi ft$

13. $e_{ave/gem}$ of/or $i_{ave/gem} = 0{,}637\ Em$ or/of Im

14. $e_{rms/wgk}$ or/fr $i_{rms/wgk} = 0{,}707\ Em$ or/of Im

15. $E_{ave/gem} = \dfrac{e_1 + e_2 + e_3 + \ldots + e_n}{n}$

or/of $I_{ave/gem} = \dfrac{i_1 + i_2 + i_3 + \ldots + i_n}{n}$

19. $I = \frac{V}{R}$

20. $X_L = 2\pi fL \; ; \; i = \frac{V}{X_L}$

21. $X_C = \frac{1}{2\pi fC} \; ; \; i = \frac{V}{X_C}$

22. $Z = \sqrt{R^2 + X_L^2} \; ; \; Z = \sqrt{R^2 + X_C^2} \; ; \; I = \frac{V}{Z}$

23. $Tan\,\theta = \frac{X_L}{R} \; ; \; Tan\,\theta = \frac{X_C}{R}$

24. $VR = I \times R \; ; \; V_L = I \times X_L \; ; \; V_C = I \times X_C$

25. $Z = \sqrt{R^2 + (X_L - X_C)^2} \; ; \; Z = \sqrt{R^2 + (X_C - X_L)^2}$

26. $\text{Tan}\,\theta = \frac{X_L - X_C}{R} \; ; \; Tan\,\theta = \frac{X_C - X_L}{R}$

27. $P = V \times I \; ; \; P = I^2 R \; ; \; P = \frac{V^2}{R}$

28. $P = VI\,\text{Cos}\,\theta$

29. $\text{Cos}\,\theta = \frac{R}{Z} \; ; \; Cos\,\theta = \frac{W \text{ or/of } KW}{VA \text{ or/of } KVA}$

30. $I_{active/aktief} = I \cos\theta$

$I_{reactive/reaktief} = I \sin\theta$

34. $I = \sqrt{I_R^2 + I_C^2}$; $Tan\ \theta = \frac{\ldots}{I_R}$

35. $I = \sqrt{I_R^2 + (I_L - I_C)^2}$; $Tan\ \theta = \dfrac{I_L - I_C}{I_R}$

36. $I = \sqrt{I_R^2 + (I_C - I_L)^2}$; $Tan\ \theta = \dfrac{I_C - I_L}{I_R}$

37. $Cos\ \theta = \dfrac{I_R}{I}$

38. $V_L = V_P$; $I_L = \sqrt{3}\, Ip$

39. $V_L = \sqrt{3}\, Vp$; $I_L = I_p$

40. $W = \sqrt{3}\ V_L I_L\ Cos\ \theta \times \eta$

41. $\dfrac{V_1}{V_2} = \dfrac{N_1}{N_2} = \dfrac{I_2}{I_1}$

42. $KVA = \dfrac{\sqrt{3}\ V_L I_L}{1\,000}$

43. $V_{shunt/sjunt} = V_{meter}$; $I_s R_s = I_m R_m$

44. $I_T = I_m + I_s$

45. $I_T = \dfrac{V_T}{R_T}$

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

ELECTRO-TECHNOLOGY N3

26MARCH 2014

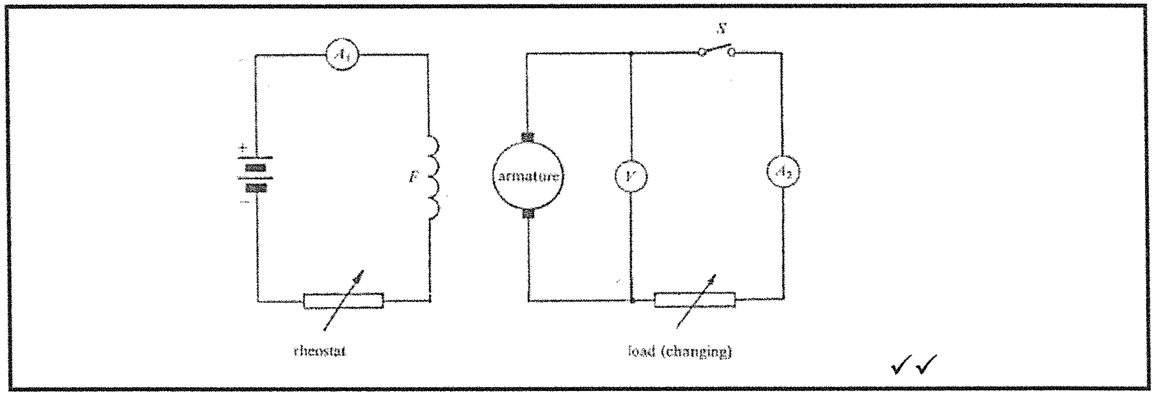
This marking guideline consists of 8 pages.

(5 x 2) **[10]**

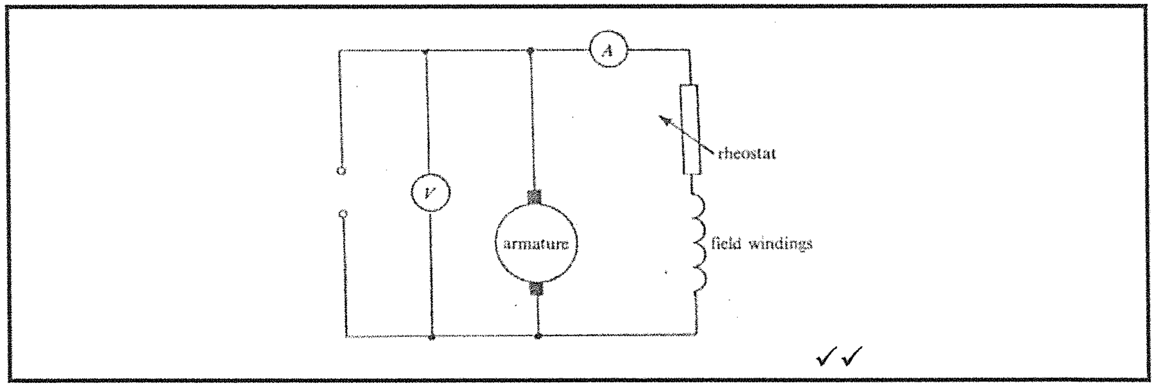
QUESTION 2

2.1
- Separately excited generator✓
- Self-excited generator✓

(2)



SEPARATELY EXCITED GENERATOR (2)



SELF-EXCITED GENERATOR (2)

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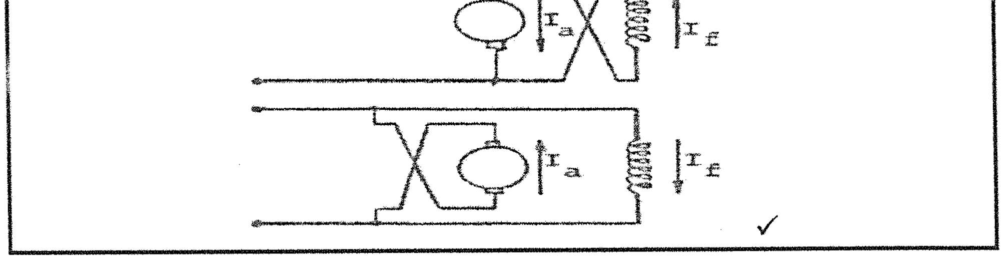
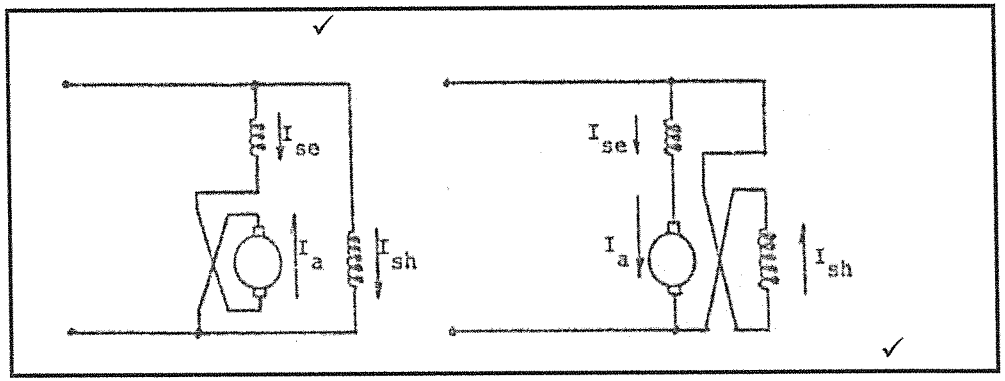


SHUNT MOTOR (2)

3.1.2



COMPOUND MOTOR (2)

3.2 ✓ It is to prevent/minimise/protect ✓ excessively high current from entering the starter. (2)

3.3 Given: $I_L = 45$ A

$R_a = 0{,}370$

$V = 180$V

EMF = $V - I_a R_a$ ✓

= 180 V – (45 A x 0,65 Ω)

= 180 V – 29,25 V✓

= 150,75 V✓

= 0,15 075 kV **OR**0,151 kV✓Answer (4)

[10]

4.2 Output power [P] ... $\frac{}{60}$

$= \frac{2\times3{,}142\times7\times425\times0{,}3}{1}$ ✓✓

= 5608,47 W✓

= 5,609 kW ⟶ Answer✓ (4)

4.3 Efficiency = $\frac{Output}{Input}\times100\%$

$= \frac{5{,}609\ kW}{7{,}26\ kW}\times100\%$ ✓

= 0,7 726 x 100%✓

= 77,26 % ⟶ Answer✓ (3)

[10]

QUESTION 5

5.1 Given: V = 220/60 Hz

5.1.1 $X_L = 2 \times 3{,}142 \times 60 \times 40 \times 10^{-3}$

= 15,082✓

$I_L = \frac{220}{15{,}082}$

= 14,587 A ⟶ Answer✓ (2)

5.1.2 $X_C = \frac{1}{2\pi fC}$

$= 1 / 2 \times 3{,}142 \times 60 \times 130 \times 10^{-6}$ ✓

= 20,401 A

$= \frac{220}{20{,}401}$

I_C = 10,783 A ⟶ Answer✓ (2)

Please turn over

$I_R \quad 4{,}933$

$= 44{,}597\ \Omega \longrightarrow$ Answer✓ (2)

[10]

QUESTION 6

Given: Incandescent lamp = 80 W/100 V. Voltage supply = 240 V/60 Hz

6.1 Power = VI

$$I = \frac{80}{100} ✓$$

$$= 0{,}8\ A \longrightarrow \text{Answer}✓$$

(2)

6.2 V = IR

$$R = \frac{V}{I}$$

$$= \frac{100}{0{,}8} ✓$$

$$= 125\ \Omega \longrightarrow \text{Answer}✓$$

(2)

6.3

$$Z = \frac{V}{I}$$

$$= \frac{240\ V}{0{,}8\ A} ✓$$

$$= 300\ \Omega \longrightarrow \text{Answer}✓$$

(2)

$2\times3{,}142\times60$

$= 0{,}723$ H or 723mH ⟶ Answer✓ (4)

[10]

QUESTION 7

7.1 Resonance frequency $[F_r] = \dfrac{1}{2\Pi\sqrt{LC}}$

$= \dfrac{1}{2\times3.142\times\sqrt{0{,}02\times70\times10^{-6}}}$ ✓✓

$= \dfrac{1}{0.007435}$ ✓✓

$= 134{,}493$ Hz ⟶ Answer✓✓ (6)

7.2
- The power factor decreases when KVA increases.✓
- Losses in the transmission lines increase (I^2R).✓
- Larger cables are needed to carry a larger current.✓
- Switches, switchgear, transformer and instruments must be capable of operation.✓

(Any 2 x 1) (2)

7.3 Capacitors✓
Synchronous machines✓ (2)

[10]

QUESTION 8

8.1 Given: $N_1 = 350$ windings
Input voltage = 210 V

8.1.1 $N_2 = \dfrac{N_1\times V_2}{V_1}$

$= \dfrac{350\times42}{210}$ ✓

$= 70$ windings ⟶ Answer✓ (2)

- It conducts the heat away from windings and core to the cooling surface.✓ (2)

8.3
- Hysteresis loss✓
- Eddy-current loss✓ (2)

[10]

QUESTION 9

9.1

9.1.1 **Deflecting torque** – causes a deflection of the pointer from its zero position.✓

9.1.2 **Controlling torque** – opposes the deflecting torque and increases with the deflection.✓

9.1.3 **Damping torque** – prevents oscillation of the moving system – enables its final position quickly.✓

(3 x 1) (3)

9.2 Given:- $I_m = 25$ mA; $R_m = 50\ \Omega$; $I_t = 1$ A

9.2.1

$V_m = I_m \times R_m$

$= 0{,}025\ A \times 50\ \Omega$

$= 1{,}25\ V \longrightarrow$ Answer✓ (1)

9.2.2 Current through shunt resistor:

$I_s = I_t - I_m$

$= 1 - 0{,}025$

$= 0{,}975\ A \longrightarrow$ Answer✓ (1)

9.2.3 Resistance of shunt:

$R_s = \frac{V_s}{I_s}$

$= \frac{1{,}25\ V}{0{,}975\ A}$ ✓

$= 1{,}282\ \Omega \longrightarrow$ Answer✓ (2)

QUESTION 10

10.1
- Common emitter
- Common collector
- Common base

(3)

10.2 3 valence electrons (1)

10.3 It has the ability to display types of wave form that must be studied (2)

10.4 Capacitor (2)

10.5 **AN AND GATE WITH TWO INPUTS**

A	B	Output	
0	0	0	✓
0	1	0	
1	1	1	
1	0	0	✓

(2)
[10]

TOTAL: 100