# Transformers
## TEST 2A

## Time allowed – 1 ½ Hours

## 15 Pages in this Question Booklet

Student Feedback / Comments

| |
|---|
| The results of my performance have been discussed and explained to me. |
| **Student:** | | **Date:** | |
| If you would like to request a review of your results or if you have any concerns about your results, contact your teacher or head teacher. |
| **Teacher:** | | **Date:** | |

TOTAL MARKS AVAILABLE

| SECTION | Possible Marks | Actual Marks |
|---|---|---|
| **A** | **20** | |
| **B** | **20** | |
| **C** | **20** | |
| **D** | **27** | |
| **TOTAL** | **87** | |

**Instructions to Students:**

- **Electronic devices are to be turned off and removed from your person.** You cannot access an electronic device during this examination.
- All questions are to be answered in the space provided in this Question Booklet.
- Answers to Section A – Multi-choice Questions, are to be recorded on the Answer Sheet attached to this Question Booklet.
- You are not to use any reference book in this examination.
- The whole of this Question Booklet is to be handed to the Supervisor upon completion.

**Aids permitted where indicated:**

| Standard Dictionaries | Bilingual Dictionaries | Technical Dictionaries | Programmable Calculators | Non-programmable Calculators | Mobile Phones | MP3 Players |
|---|---|---|---|---|---|---|
| **No** | **Yes** | **No** | **No** | **Yes** | **No** | **No** |

# Section A -Multiple Choice - (20 Marks)

**Select the best answer for the following statements and place an "X" in the appropriate box on the Answer Sheet attached to this examination paper. Each correct answer is worth ONE (1) mark.**

1. The No-Load current of a transformer is:

   a) The magnetising current only.
   b) The iron loss current only.
   c) The sum of the magnetising and iron loss currents.
   d) The phasor sum of the magnetising and iron loss currents.

2. Regulation of transformers relates to:

   a) The change in primary current to secondary current.
   b) The change in no load secondary current to full load secondary voltage.
   c) The change in no load secondary voltage to full load primary voltage.
   d) The change in no load secondary voltage to full load secondary voltage.

3. The main purpose of conservators on oil filled transformers is to:

   a) Allow the oil to be topped up in the transformer.
   b) Allow for the expansion of the heated oil.
   c) Provide a reserve of oil in case of leaks.
   d) Allow the escape of oil in the event of an explosion.

4. An auto transformer:

   a) Has two electrically isolated windings.
   b) Has electrical and magnetic isolation.
   c) Has the same number of primary and secondary turns.
   d) Has a part of the primary and secondary winding electrically common.

5. The frequency of the third harmonic on a normal mains power system is:

   a) 50 Hz.
   b) 100 Hz.
   c) 150 Hz.
   d) 200 Hz.

6. If two secondary windings of a transformer, rated at 10 V and 2.4 A, are connected in series the total voltage and current available from the system will be:

   a) 10 V and 2.4 A.
   b) 10 V and 4.8 A.
   c) 20 V and 2.4 A.
   d) 20 V and 4.8 A.

7. The recommended full load current of the low voltage winding for a transformer whose specifications are:

   **1000 VA  250/25 V  50 Hz**

   Will be:

   a) 0.4 A.
   b) 4 A.
   c) 40 A.
   d) 400 A.

8. The primary current of a 10:1 step down transformer which supplies a load current of 200A will be:

   a) 200 A.
   b) 20 A.
   c) 2 A.
   d) 0.2 A.

9. The maximum efficiency of a transformer occurs when:

   a) The copper losses and iron losses are equal.
   b) The copper losses and iron losses are not equal.
   c) The paint softens and begins to melt.
   d) The transformer Hums.

10. The material used to reduce moisture contamination in transformer oil is:

    a) Ammonium persulphate.
    b) Potassium hydroxide.
    c) Hydrated lime.
    d) Silica gel.

11. Transformer oil expands due to:

    a) Heating of the oil.
    b) The generation of gas bubbles due to faults in the generator.
    c) The expansion of the windings at full load.
    d) The expansion of the core at full load.

12. If an instrument is to be removed from the secondary of a current transformer it is necessary to:

    a) Short circuit the primary winding.
    b) Short circuit the secondary winding.
    c) Open circuit the primary winding.
    d) Open circuit the secondary winding.

13. The short circuit test is used to determine the transformers:

    a) Apparent losses.
    b) Reactive losses.
    c) Copper losses.
    d) Iron losses.

14. The drop in the secondary terminal voltage from No Load to Full Load of a transformer is the:

    a) Primary impedance voltage drop.
    b) Combined primary and secondary impedance voltage drop.
    c) Reactive impedance voltage drop.
    d) Resistive impedance voltage drop.

15. The main function of the oil in an oil filled transformer is to:

    a) Dissipate the heat produced in the windings.
    b) Insulate the windings from the tank.
    c) Lubricate the windings when overloaded.
    d) Prevent the iron laminations from oxidising.

16. Before any work is carried out on high voltage conductors or equipment:

    a) An access path must be opened.
    b) Danger tags must be carried.
    c) An access permit must be obtained.
    d) All conductors must be exposed.

17. For three phase transformers to operate in parallel their:

    a) Supply frequency and percentage impedance ***must*** be the same.
    b) Secondary terminal voltage and phase sequence ***must*** be identical.
    c) Load ratings ***must*** be similar.
    d) Ability to dissipate heat ***must*** be in proportion to their rating.

18. An access permit is:

    a) An authority to work in an area which has been isolated and made safe.
    b) An authority to work anywhere.
    c) A verbal agreement to start work.
    d) An authority to enter an area but not to do any work on equipment in that area.

Cont.....

19. A three phase transformer marked ***Dy11*** has a:

a) Delta connected Primary, and a star connected Secondary with a lagging phase angle of 30°.
b) Delta connected Primary, and a star connected Secondary with a leading phase angle of 30°.
c) Delta connected Secondary, and a star connected Primary with a lagging phase angle of 30°.
d) Delta connected Secondary, and a star connected Primary with a leading phase angle of 30°.

20. To find the percentage impedance of a transformer we can perform:

a) A full load test.
b) An insulation test.
c) An open circuit test.
d) A short circuit test.

## Section B- Short answer. (20 marks)

1. State the winding connections and phase shift of a transformer having the notation Yy0.

2. State two characteristics that two transformers must have to operate in parallel satisfactory.

3. Name the device which provides protection for a transformer by detecting fluid surges or gas bubbles.

4. What component is fitted to oil filled transformers which allows for the expansion of the oil.

5. State the device and the material it contains which is fitted to prevent moisture entering a transformers.

6. What is the purpose of tap changers on distribution transformers?

7. State the type of transformer which must have its secondary winding short circuited prior to removal of its associated metering.

8. What are instrument transformers usually rated in.

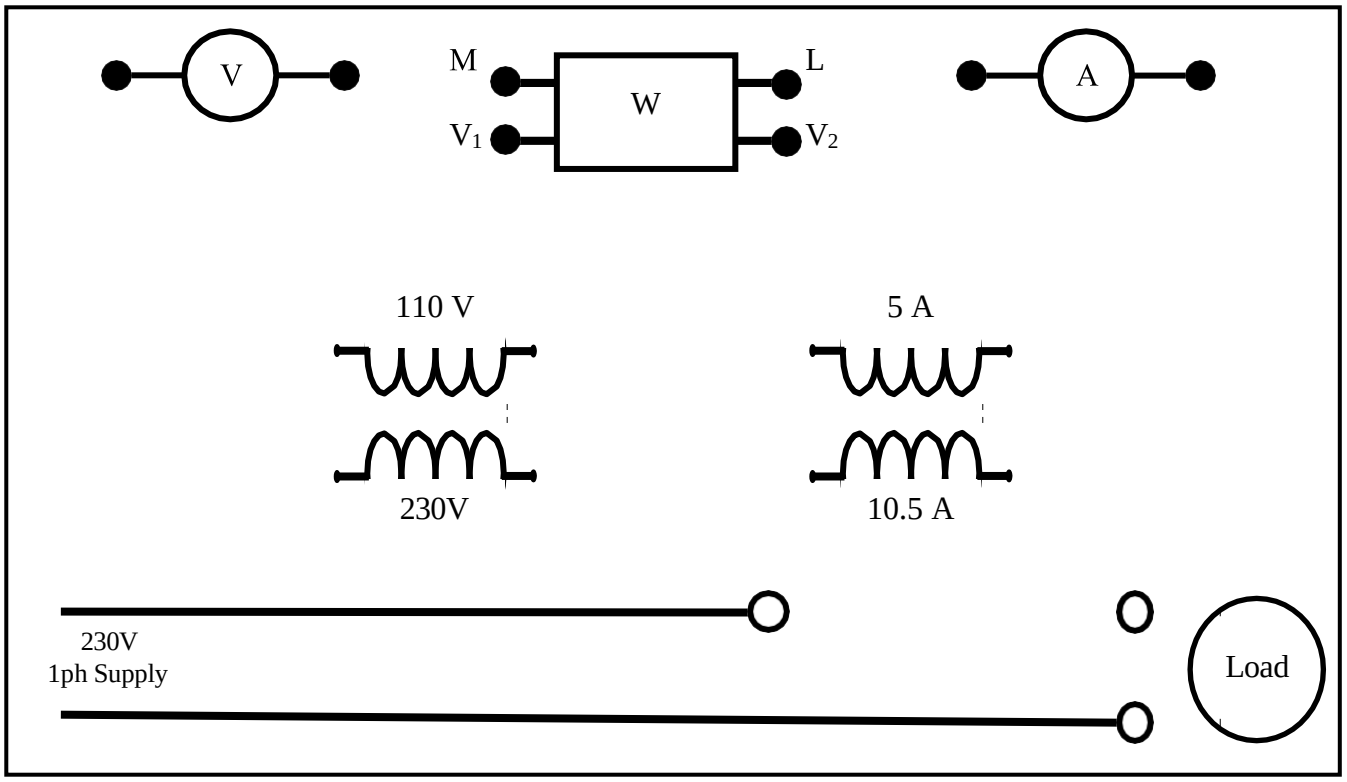
9. State the two main categories' of tap changing switches.

10. Name the test which determines the iron losses within a transformer

## Section C – Drawings and Diagrams (20 Marks)

**The questions in this section require some simple drawing. Ensure that drawings are neat and legible. The use of pencil on drawings is acceptable in this section only. Marks are as indicated.**

1. Complete the diagram to show how the Voltage, Current and Power can be measured by the appropriate instruments. (The Voltmeter has a FSD of 110 V; the Ammeter has a FSD of 5A.) *(6 marks)*




2. In the readings on the Voltmeter and Ammeter were 94V and 4.2A respectively, determine:

*(6 marks)*

i. The Supply Voltage

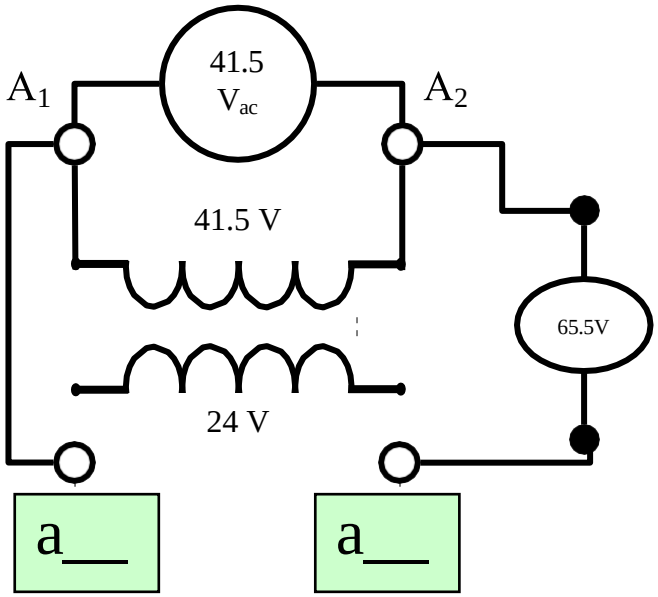
ii. The Line Current

iii. The Power for a load with a power factor of unity.

3. Examine the following polarity test circuits. (2 marks)

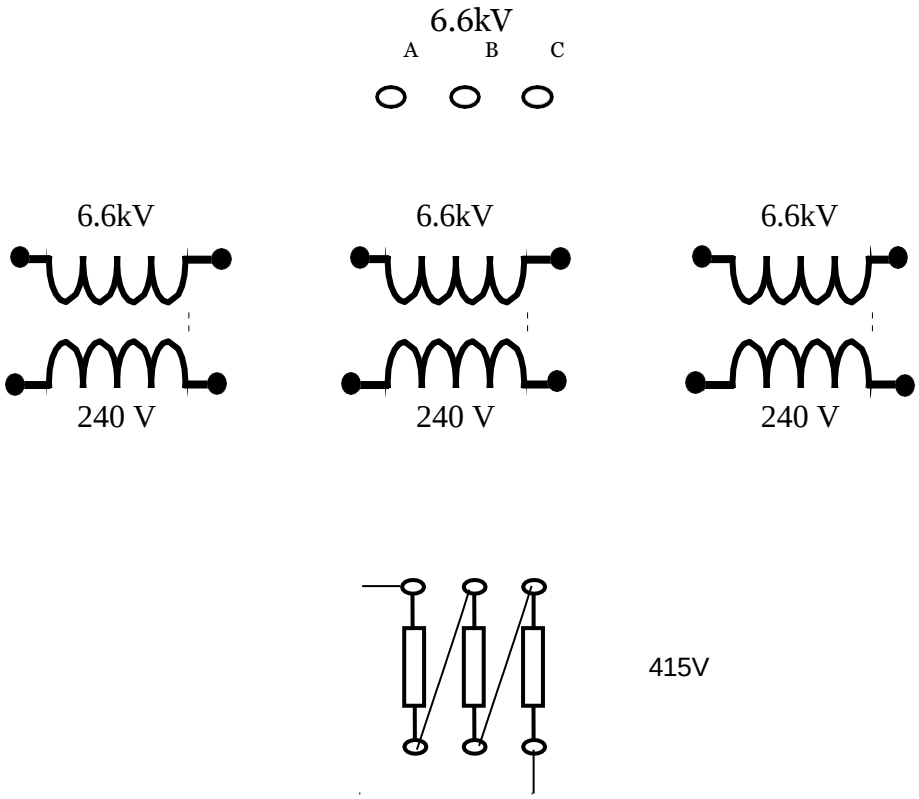
   a) Identify the type of polarity the windings would indicate (Additive or Subtractive)

   _____




   b). Indicate on the diagram the polarity of the secondary terminals.

4. A three phase transformer has a transformer ratio of 6.6kV/240. Draw the connections required to supply a 415V delta load. (6 Marks)



## Section D -calculations (27 Marks)

**This section involves calculations. Show all necessary working in the space provided, marks will be awarded accordingly. Answers are to be written in the spaces provided and limited to two (2) decimal places**.

1. A transformer, operating at maximum efficiency of 90%, supplies 9 kW to a resistive load. Determine: (4 marks)

   a) The copper losses

   b) The iron losses

2. The output voltage of a 415 / 240 V transformer falls to 232 V under full load. Calculate the percentage regulation of this transformer. (2 Marks)

3. How many turns are required on *each* winding of an **11kV / 415V 50Hz** single phase transformer if the flux linking the primary and secondary coils is 300 mWb.

   (4 Marks)

4. A 230 / 32 V Auto-transformer supplies a 16Ω resistive load. Determine the: (6 marks)

   a) Secondary Current

   b) Primary Current

   c) Current in the common section of the transformer

5. If a **100 kVA, 415 / 230 V 50 Hz** single phase transformer is connected to a load with unity power factor, determine: (4 marks)

   a) the output power in kilo watts

   b) the rated full load secondary current

6. A 60 kVA transformer with an impedance of 5.5 % is to be paralleled with another 60 kVA transformer whose impedance is 6.0 % to supply a load of 120 kVA. For the transformers operating in parallel determine:

   a) the load on the 5.5 %, 60 kVA transformer (TxA) (2 Marks)

   b) the load on the 6%, 60 kVA transformer, and (TxB) (2 Marks)

   c) if each transformer is working within its stated capabilities. (1 Mark)

7. A **5MVA, 33kV/11Kv** transformer is short circuited on the secondary winding. If a primary voltage of 2.31kV is required to cause the full load current to flow in the secondary, calculate the percentage impedance of the transformer. (2 marks)

END

Name: _____

Class: _____

Date: _____

# ANSWER SHEET

## Section A (Multiple Choice Questions)

**Enter your personal details in the top right hand corner of this sheet.**
**Place an X in box of your choice. If you make a mistake, circle your answer ⊗ and choose again.**

| Question | A. | B. | C. | D. |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | | | | |

**Total Marks Section A:** _____

Note: The symbols used on this sheet follow AS1046 pt 1. There are alternate recognised symbols in use. The list does not contain every equation used in the course. Transposition of equations will be necessary to solve problems

$$Q = It$$

$$v = \frac{s}{t}$$

$$a = \frac{\Delta v}{t}$$

$$F = ma$$

$$W = Fs$$

$$W = mgh$$

$$W = Pt$$

$$\eta\% = \frac{output}{} \times \frac{100}{}$$

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

$$P = VI$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

$$R = \frac{R_1 A_1 l_2}{2\ 1}$$

$$R_h = R_c(1+\alpha\Delta t)$$

$$R = \frac{\rho l}{A}$$

$$R_T = R_1 + R_2 + R_3$$

$$V_T = V_1 + V_2 + V_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$I_T = I_1 + I_2 + I_3$$

$$V = V \frac{R_2}{1\quad 2}$$

$$I_2 = I_T \frac{R_1}{R_1 + R_2}$$

$$R = \frac{R_A R}{B}$$

$$C = \frac{Q}{}$$

$$\tau = RC$$

$$\frac{1}{} = \frac{1}{} + \frac{1}{} + \frac{1}{}$$

$$C_T = C_1 + C_2 + C_3$$

$$C = \frac{A\varepsilon_o\varepsilon_r}{d}$$

$$F_m = IN$$

$$H = \frac{F_m}{}$$

$$B = \frac{\Phi}{A}$$

$$\Phi = \frac{F_m}{}$$

$$S = \frac{l}{\mu_o\mu_r A}$$

$$V = N\frac{\Delta\Phi}{\Delta t}$$

$$e = Blv$$

$$\mu\ \mu\ AN^2 \over l$$

$$L = N\frac{\Delta\Phi}{\Delta I}$$

$$V = L\frac{\Delta I}{}$$

$$\tau = \frac{L}{}$$

$$F = Bil$$

$$T = Fr$$

$$E = \frac{\Phi ZnP}{}$$

$$P = \frac{2\pi nT}{60}$$

$$t = \frac{1}{}$$

$$f = \frac{np}{}$$

$$V = 0.707V_{\max}$$

$$I = 0.707I_{\max}$$

$$V_{ave} = 0.637V_{\max}$$

$$I_{ave} = 0.637I_{\max}$$

$$v = V_{\max}\sin\phi$$

$$i = I_{\max}\sin\phi$$

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

$$Z = \sqrt{R^2 + (X\ -X\ )^2}$$

$$X_L = 2\pi fL$$

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

$$\cos\phi = \frac{P}{}$$

$$\cos\phi = \frac{R}{}$$

$$S = \sqrt{P^2 + Q^2}$$

$S = VI$ $P = VI\cos\phi$ $Q = VI\sin\phi$

$f_o = \frac{1}{2\pi\sqrt{LC}}$ $V_L = \sqrt{3}V_P$ $I_L = \sqrt{3}I_P$

$S = \sqrt{3}V_L I_L$ $P = \sqrt{3}V_L I_L\cos\phi$ $Q = \sqrt{3}V_L I_L\sin\phi$

$\tan\phi = \sqrt{3}\left|\frac{W_2 - W_1}{W_2 + W_1}\right|$ $Q = mC\Delta t$

$V' = 4.44\Phi fN$ $\frac{V_1}{V_2} = \frac{N_1}{N_2}$ $\frac{I_2}{I_1} = \frac{N_1}{N_2}$

$N_{syn} = \frac{120f}{p}$ $s\% = \frac{(n_{syn} - n)}{n_{syn}} \times \frac{100}{1}$ $f_r = \frac{s\% \times f}{100}$

$V_{reg}\% = \frac{(V_{NL} - V_{FL})}{V_{FL}} \times \frac{100}{1}$ $V_{reg}\% = \frac{(V_{NL} - V_{FL})}{V_{NL}} \times \frac{100}{1}$ $T = \frac{\Phi ZIP}{2\pi a}$

$I_{ST} = \frac{1}{3} \times I_{DOL}$ $T_{ST} = \frac{1}{3} \times T_{DOL}$ $I_{ST} = \frac{V_{ST}}{V_{DOL}} \times I_{DOL}$

$T_{ST} = \left|\frac{V_{ST}}{V}\right|^2 \times T_{DOL}$ $I_{motor\,st} = \frac{\%TAP}{100} \times I_{DOL}$ $I_{line\,st} = \left|\frac{\%TAP}{100}\right|^2 \times I_{DOL}$

$E = \frac{\Phi_v}{A}$ $E = \frac{I}{d^2}$ $\eta_v = \frac{\Phi_v}{P}$

$V_L = 0.45V_{ac}$ $V_L = 0.9V_{ac}$ $V_L = 1.17V_{phase}$

$V_L = 1.35V_{line}$ $PRV = \sqrt{2}V_{ac}$ $PRV = 2\sqrt{2}V_{ac}$

$PRV = 2.45V_{ac}$ $V_{ripple} = \sqrt{2}V_{ac}$ $V_{ripple} = 0.707V_{phase}$

$V_{ripple} = 0.1895V_{line}$