education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

ELECTRICAL TECHNOLOGY

FEBRUARY/MARCH 2009

MARKS: 200

TIME: 3 hours

This question paper consists of 12 pages and 1 formula sheet.

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INSTRUCTIONS AND INFORMATION

1. This question paper consists of TEN questions.
2. Answer ALL the questions.
3. Sketches and diagrams must be large, neat and fully labelled.
4. ALL calculations must be shown and should be rounded off correctly to TWO decimal places.
5. Number the answers correctly according to the numbering system used in this question paper.
6. A formula sheet has been attached at the end of this question paper.
7. Non-programmable calculators may be used.

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QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1 Technology, as a solution to the needs of the country, has affected cultures differently.

Discuss THREE examples of how technology has affected your culture in this country. (6)

1.2 The environment in which Electrical Technology is practised must comply with the human rights and work ethics principles. You are employed as a supervisor at Majozi Electrical Company which manufactures electrical components.

Discuss how you will promote these principles with reference to:

1.2.1 Inclusivity (2)

1.2.2 Gender (2)
[10]

QUESTION 2: THE TECHNOLOGICAL PROCESS

2.1 Investigation is part of the technological process. It leads to a clear understanding of the design problem.

Describe FIVE methods used to gather information in the investigation of a problem. (5)

2.2 Physically disabled children need to practise how to control electrically powered wheelchairs in order to avoid accidents.

Develop a design brief to solve the above-mentioned problem. (5)
[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1 Name ONE precaution that must be taken when using a grinding machine. (1)

3.2 Explain why the precaution in QUESTION 3.1 must be taken. (2)

3.3 Explain why no person under the influence of drugs may enter or remain in a workplace where machinery is used. (2)

3.4 Name TWO unsafe acts that should NOT take place in the workplace. (2)

3.5 The earth leakage protection unit was pioneered in South Africa. Describe how this unit can protect a person from an electric shock when an electrical appliance is used. (3)

[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1 Name TWO advantages that a three-phase system has over a single-phase system. (2)

4.2 State what a wattmeter measures when compared to a kilowatt-hour meter connected in a circuit. (2)

4.3 A three-phase balanced load is connected in delta across a 380 V supply. The load draws a current of 5 A and has a power factor of 0,9.

Calculate the following:

4.3.1 The current in each phase of the load (3)

4.3.2 The total power dissipated by the load (3)

[10]

QUESTION 5: R, L AND C CIRCUITS

5.1 Identify the opposition offered to the flow of current in the following alternating current circuits:

5.1.1 Purely inductive (1)

5.1.2 Resistance, inductance and capacitance together in a circuit (1)

5.1.3 Purely capacitive (1)

5.2 A tuned circuit consists of a resistor with a resistance of 20 Ω, a capacitor with a capacitance 147 µF and an inductor with an inductance of 15 mH. This circuit is connected in series across a 220 V/50 Hz supply.

Calculate the following:

5.2.1 X_L (3)

5.2.2 X_C (3)

5.2.3 Z (3)

5.2.4 The current flowing through the circuit (3)

5.2.5 The voltage drop across the resistor (3)

5.3 The phasor diagram in FIGURE 5.1 indicates the current values through the components of a parallel circuit consisting of a resistor, a capacitor and an inductor, all connected across a 220V/50 Hz supply.

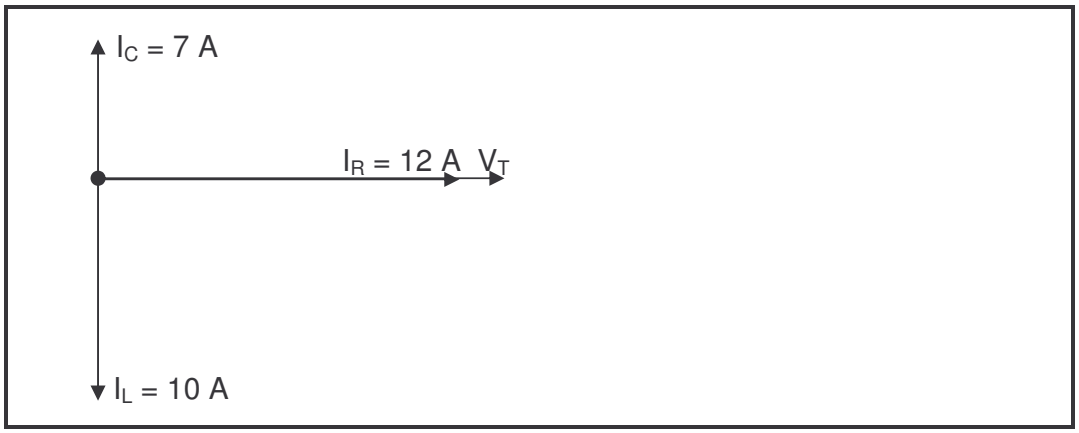

FIGURE 5.1 – PHASOR DIAGRAM OF AN RLC PARALLEL CIRCUIT

Calculate the following:

5.3.1 The total current flowing through the circuit (3)

5.3.2 The impedance of the circuit (3)

5.3.3 The capacitance of the capacitor (6)

[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

6.1 Draw a fully labelled symbol of an SCR (silicon controlled rectifier). (3)

6.2 Explain the conditions that should exist in order to turn an SCR (thyristor) on and off. (5)

6.3 FIGURE 6.1 uses a TRIAC and a DIAC to control the brightness of a lamp that is connected to a household supply. Explain how this circuit achieves control of the lamp.

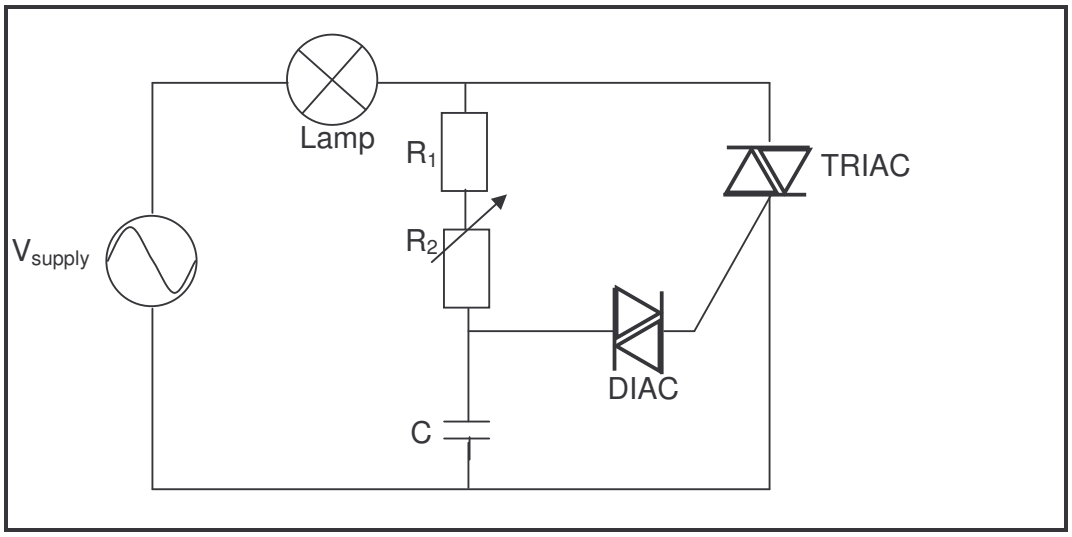

FIGURE 6.1 – LAMP DIMMER (12)

6.4 Draw a fully labelled characteristic curve of an SCR (thyristor). (5)
[25]

QUESTION 7: AMPLIFIERS

7.1 The operational amplifiers shown in FIGURE 7.1 and FIGURE 7.2 are connected in the circuit of a television set.

Draw the output wave forms of each circuit and name the mode in which the circuit is connected.

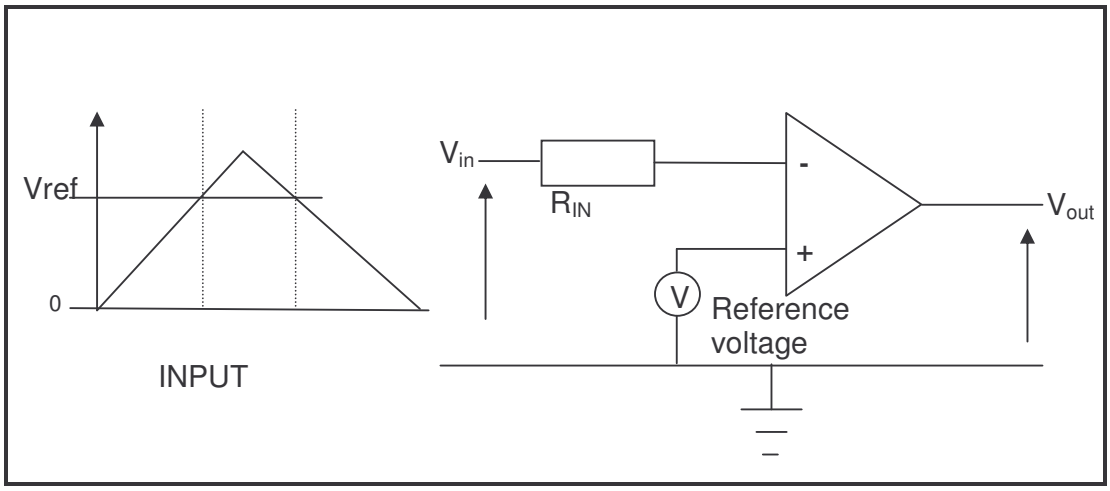

FIGURE 7.1 – OPERATIONAL AMPLIFIER (4)

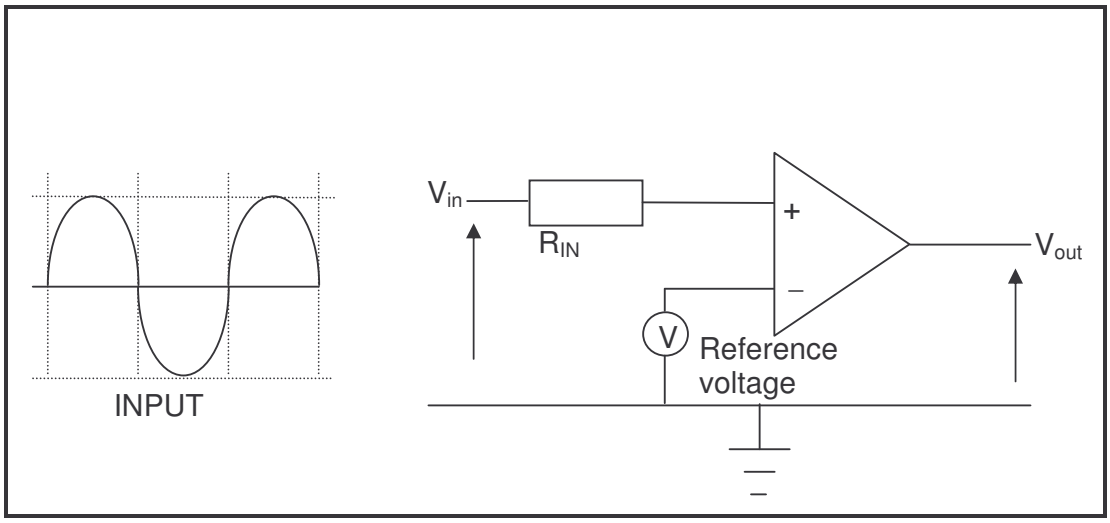

FIGURE 7.2 – OPERATIONAL AMPLIFIER (4)

7.2 The phase shift oscillator shown below in FIGURE 7.3 is used in a circuit. If each resistor has a value of 1 kΩ and each capacitor has a value of 100 pF, calculate the following:

7.2.1 The total phase shift of the oscillator (3)

7.2.2 The oscillation frequency of the oscillator (3)

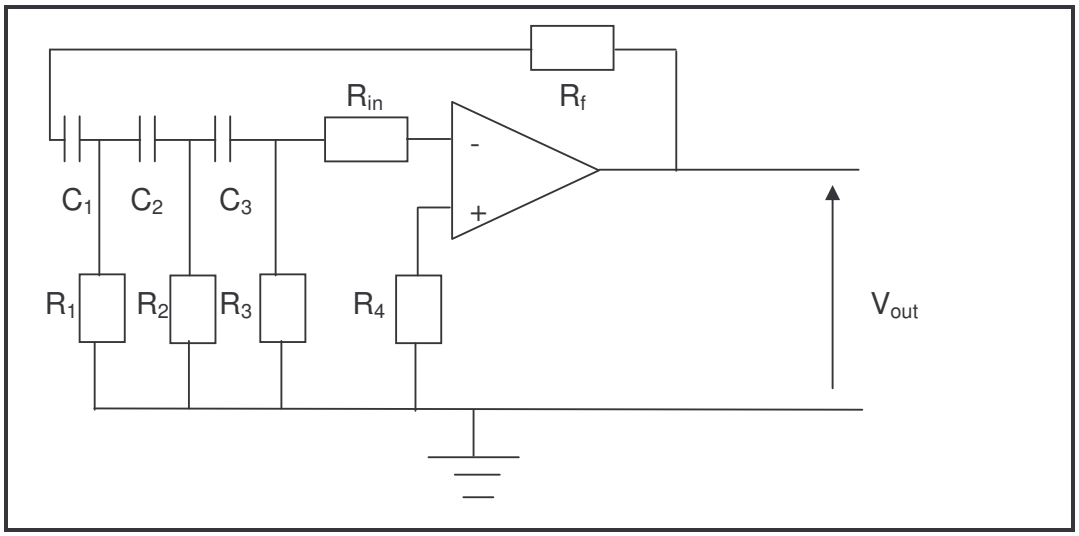

FIGURE 7.3 – PHASE SHIFT OSCILLATOR

7.3 Explain the term *positive feedback*. (4)

7.4 In order for a circuit to operate as an amplifier, certain conditions must be present. Name THREE conditions. (3)

7.5 Name THREE output characteristics of transistors. (THREE areas) (3)

7.6 Name ONE method of biasing a common emitter amplifier. (1)
[25]

QUESTION 8: THREE-PHASE TRANSFORMERS

8.1 The oil used in tanks of large transformers serves a dual purpose. Name the dual purpose of the oil. (2)

8.2 A new school is under construction. The school will be fed from an 11 kV supply. The school requires a single-phase and a three-phase supply.

Draw a schematic diagram to show how the primary and the secondary of the transformer supplying the school will be connected. (4)

8.3 Three single-phase transformers are connected in delta-star to form one three-phase transformer. The supply voltage is 11 kV and the turns ratio is 45:1. Ignore the transformer losses and calculate at full load:

8.3.1 The secondary phase voltage (3)

8.3.2 The secondary line voltage (3)

8.4 A three-phase 250 kVA transformer has a star-connected secondary with a phase voltage of 220 V. Calculate the output power of the transformer at a power factor of 0,8 lagging. (3)

[15]

QUESTION 9: LOGIC CONCEPTS AND PLC'S

9.1 Identify the main components, indicated by numbers 1 to 4, of the programmable logic controller (PLC) shown in FIGURE 9.1.

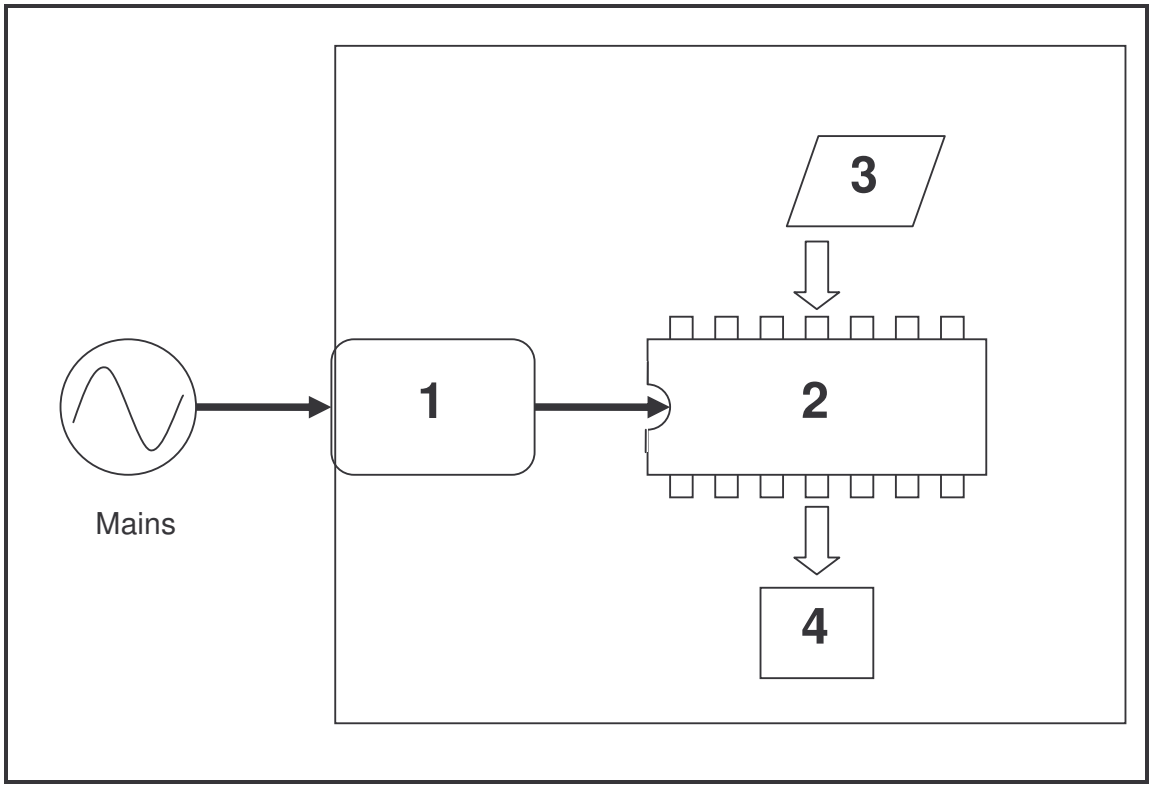

FIGURE 9.1 – PROGRAMMABLE LOGIC CONTROLLER (PLC) (4)

9.2 Name THREE programming methods used in programmable logic controllers. (3)

9.3 Draw the symbols of the following, using one of the programming languages for programmable logic controllers (PLC):

9.3.1 Normally open switch (1)

9.3.2 Relay or other device used as an output (1)

9.3.3 Normally closed switch (1)

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9.4 Draw the ladder diagram of the circuit shown in FIGURE 9.2 below.

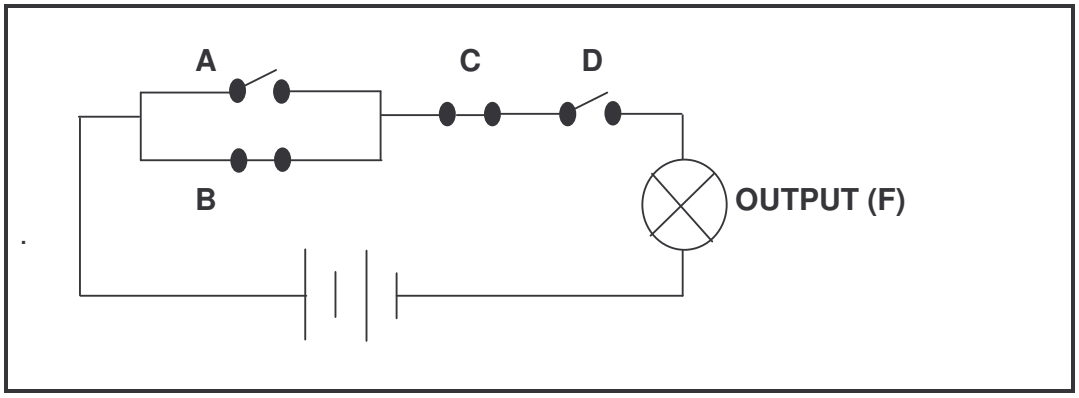

FIGURE 9.2 – SERIES AND PARALLEL CIRCUIT (4)

9.5 With reference to the logic circuit in FIGURE 9.3 below:

9.5.1 Determine the Boolean equation of the logic circuit. (2)

9.5.2 Simplify the Boolean equation generated by applying De Morgan's law.

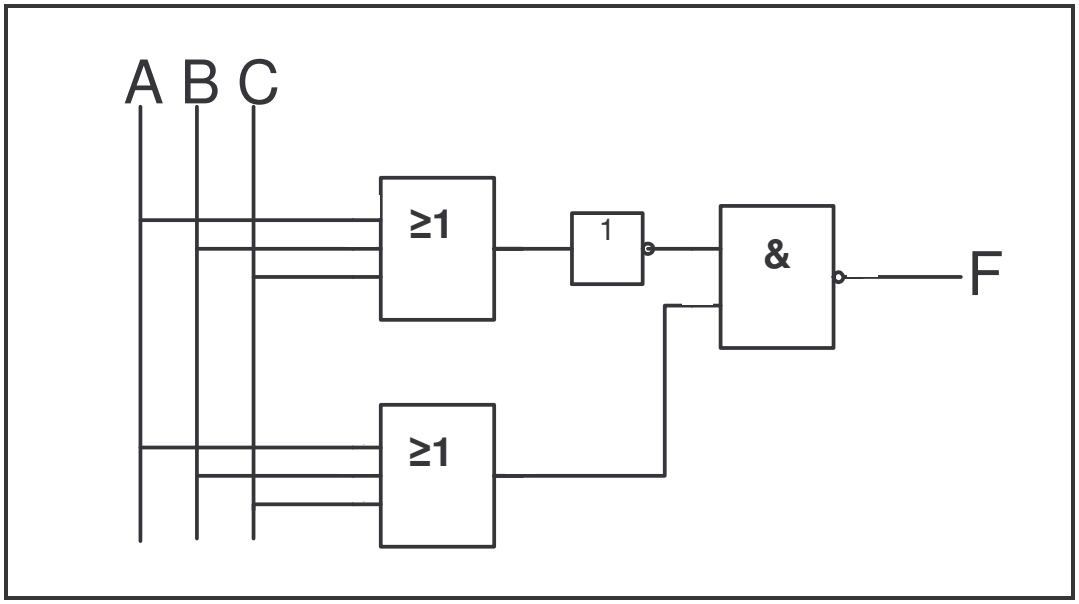

FIGURE 9.3 – LOGIC CIRCUIT (4)

9.6 Draw the logic gate network that would represent the following Boolean equation:

$$F = \overline{A}.B.\overline{C} + \overline{A}.\overline{B}.C + \overline{A}.B.\overline{C} + \overline{A}.\overline{B}.\overline{C}$$ (10)

9.7 Draw a fully labelled symbol of a full adder. (5)

[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 Describe the function of a star-delta motor starter. (2)

10.2 Explain how a star-delta starter achieves its function. (5)

10.3 Explain the basic operation of a three-phase squirrel-cage induction motor. (8)

10.4 With reference to motor starters, describe the function of an emergency stop button and state where it must be located. (3)

10.5 Explain the term *normally open* with reference to motor starters. (2)

10.6 A three-phase, star-delta connected motor develops 6,5 kW at an efficiency of 95%. The motor is connected to a 380 V supply and has a power factor of 0,85 at full load. Calculate the following:

10.6.1 The apparent power of the motor (6)

10.6.2 The reactive power of the motor (4)
[30]

TOTAL: 200

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FORMULA SHEET/FORMULEBLAD

$$X_L = 2\pi FL$$

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

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

$$I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$$

$$V_T = \sqrt{V_R^2 + (V_C - V_L)^2}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$Q = \frac{X_L}{R} = \frac{V_L}{V_R}$$

$$Cos\theta = \frac{I_R}{I_T}$$

$$Cos\theta = \frac{R}{Z}$$

$$\left.\begin{aligned} P &= VI\cos\theta \\ S &= VI \\ Q &= VI\sin\theta \end{aligned}\right\}$$ Single phase/ Enkelfase

$$\left.\begin{aligned} P &= \sqrt{3}\, V_L I_L \cos\theta \\ S &= \sqrt{3}\, V_L I_L \\ Q &= \sqrt{3}\, V_L I_L \sin\theta \end{aligned}\right\}$$ Three phase/ Driefase

$$\left.\begin{aligned} V_L &= V_{Ph} \\ I_L &= \sqrt{3} I_{PH} \end{aligned}\right\}$$ Delta

$$\left.\begin{aligned} V_L &= \sqrt{3}\, V_{Ph} \\ I_L &= I_{Ph} \end{aligned}\right\}$$ Star/Ster

$$f = \frac{1}{T}$$

$$Av = \frac{R_f}{R_{in}} + 1$$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

$$\eta = \frac{P_O}{P_I}$$

$$\beta = \frac{I_c}{I_b}$$

$$I_b = I_e - I_c$$

$$P_G = 10\log\frac{P_0}{P_i}$$

$$f_r = \frac{1}{2\pi(6RC)^{1/2}}$$

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