Province of the
EASTERN CAPE
EDUCATION

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REPUBLIC OF SOUTH AFRICA

CHIEF DIRECTORATE – CURRICULUM MANAGEMENT

GRADE 12 LEARNER SUPPORT PROGRAMME

REVISION AND REMEDIAL TEACHING INSTRUMENT: ANSWERS

SUBJECT: ELECTRICAL TECHNOLOGY

June 2009

This document consists of 13 pages.

Strictly not for test/examination purposes

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

1.1
- Inequality✓
- Age✓
- Disability✓
- Race✓
- Gender✓
- Language✓ (5)

1.2
- Race✓
- Sexual orientation✓
- Culture✓
- Colour✓ (Give ANY 3 x 1) (3)

1.3
- Solar✓
- Wind✓
- Wave✓
- Tidal✓ (4)

1.4
- Computers ✓
- Laptops ✓ (Give ONLY 1 x 1) (1)

1.5 They have to think of something that has no effect on the environment.✓✓ (2)

[15]

QUESTION 2: THE TECHNOLOGICAL PROCESS

2.1
- Identify the problem✓
- Investigate✓
- Research✓
- Access✓
- Process✓ (5)

2.2 On reaching old age, some elderly people find it very difficult, and often frightening, to climb up and down stairs. ✓✓ (1)

2.3 I am going to design a wheelchair,✓ that will transport Mrs Sebola up and down the stairs. ✓✓ (3)

2.4 The electrical system must adhere to the following criteria:
- The motor must be strong enough to handle the weight of the passenger as well as the weight of the device itself. ✓
- The motor must be able to rotate in both directions or change direction✓
- The device must have a braking system✓
- The device must contain limit switches✓
- The device must contain over current protection✓
- The device must contain earth protection✓ (6)

[15]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY ACT

3.1
- Lighting✓
- Windows✓
- Ventilation✓
- Noise and hearing conservation✓ (Any 3) (3)

3.2
- Contact✓
- Droplet transmission✓
- Airborne transmission✓
- Common vehicle transmission✓
- Vector borne transmission✓ (5)

3.3
- Blood pressure increases✓
- Irregular heart beat✓ (2)

3.4
- Wear safety belt when working on a ladder✓
- One must also have shoulder or waist pouch in which to keep tools and equipment while working✓
- Ensure that people do not stand underneath you while you are working.✓ (Any 2) (2)

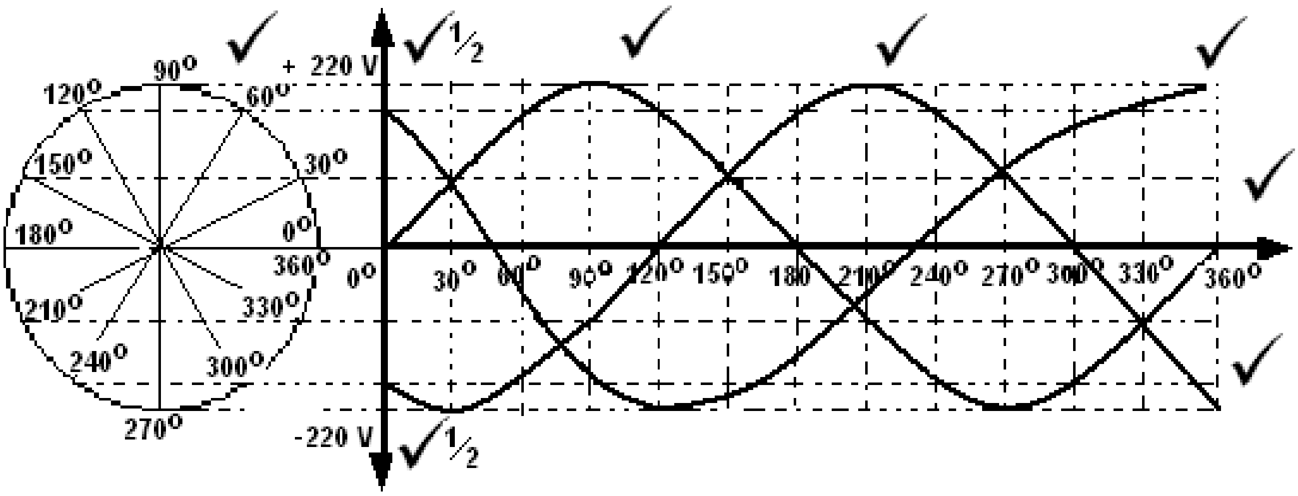
3.5
- Supervision of machinery✓
- Safeguarding of machinery✓
- Operation of machinery✓
- Working on moving or electrically alive machinery✓

(Any 3) (3)

[15]

QUESTION 4: THREE-PHASE AC GENERATION

4.1



(7)

4.2 4.2.1 Phase values : $V_P = 230$ V
$I_L = I_P = 20$ A✓

Total Power = $3 \times V_P \times I_P \times \cos\theta$ ✓½
= $3 \times 230 \times 20 \ \cos 30^o$ ✓½
= 11,95 kW✓ (3)

4.2.2 Line values: $I_L = I_P = 20$ A
$V_L = \sqrt{3} \times V_P$ ✓½
= $\sqrt{3} \times 230$
= 398,37 V✓½

Total Power = $\sqrt{3 \times V_L \times I_L \times \cos\theta}$ ✓½
= $\sqrt{3} \times 398,37 \times 20 \times \ \cos 30^o$ ✓½
= 11,95 kW ✓ (3)

4.3
- A three-phase supply has three times power than a single supply.✓
- Load distribution and a phase balancing are possible with a three-phase supply.✓
- Three-phase supply system has two voltages.✓ (Any 2) (2)

[15]

QUESTION 5: PRINCIPLE OF AC ON R, L AND C COMPONENTS

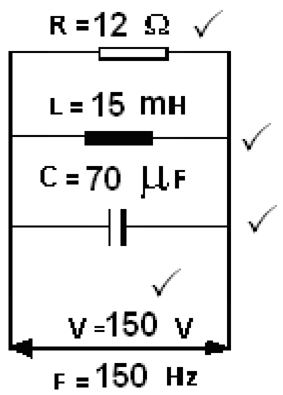
5.1 5.1.1 The inductive reactance will increase. ✓ (1)

5.1.2 The capacitive reactance will decrease. ✓ (1)

5.2
- $X_L = X_C$. ✓
- $I_L = I_C$. ✓
- Z is minimum. ✓
- $\theta = 0^o$. ✓
- $I_T = I_R$. ✓
- I is minimum. ✓
- $f_R = \frac{1}{2\pi (LC)^{1/2}}$ ✓

(Any 3) (3)

5.3 5.3.1



(4)

5.3.2 (a) $X_L = 2\pi fL$ ✓½

$= 2\pi.150.15.10^{-3}$ ✓½

$= 14{,}14\ \Omega$ ✓ (2)

(b) $X_C = \frac{1}{2\pi fC}$ ✓½

$= \frac{1}{2.\pi.150.70 \times 10^{-6}}$ ✓½

$= 15{,}16\ \Omega$ ✓ (2)

(c) $I_R = \frac{V_S}{R}$ ✓½ $= \frac{150}{12}$ ✓½ $= 12{,}5\ \Omega$ ✓

$I_L = \frac{V_S}{X_L}$ ✓½ $= \frac{150}{14{,}14}$ ✓½ $= 10{,}61\ \Omega$ ✓

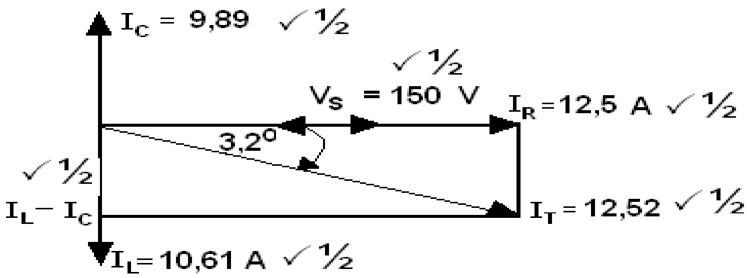
$I_C = \frac{V_S}{X_C}$ ✓½ $= \frac{150}{15{,}16}$ ✓½ $= 9{,}89\ \Omega$ ✓ (6)

5.3.3 $I_T = \sqrt{[I_R^2 + (I_L - I_C)^2]}$ ✓
$= \sqrt{[12,5^2 + (10,61 - 9,89)^2]}$ ✓
= 12,52 A✓ (3)

5.3.4 $\cos\theta = \frac{I_R}{I_T}$ ✓½
$= \frac{12,5}{12,52}$ ✓½
= 0,998✓½
$\Theta = \cos^{-1} 0,998$✓½
= 3,2°✓ (3)

5.3.5 $Z = \frac{V_S}{I_T}$ ✓½
$= \frac{150}{12,52}$ ✓½
= 11,98 Ω✓ (2)

5.3.6



(3)

5.4 fr $= \frac{1}{2\pi\sqrt{lc}}$ ✓

$= \frac{1}{2\pi\sqrt{300 \times 10^{-3} X\ 47 \times 10^{-6}}}$ ✓✓

= 42,4 Hz (4)

5.5
- Power factor correcting capacitor✓✓
- Synchronous motor with various excitations in parallel. ✓✓ (4)

5.6
- True power is the power that is dissipated as a heat by the internal resistance. ✓
- Apparent power is the combination of true power and reactive power✓ (2)

[40]

QUESTION 6: OPERATING PRINCIPLES OF THREE-PHASE MOTORS AND CONTROL

6.1
- When the motor is connected to a supply, current starts flowing in the windings of the stator. ✓
- Owing to the phase difference of the current, a rotating magnetic field is produced in the stator. ✓
- The rotating field cuts the static rotor conductors, inducing emfs and currents in them. ✓
- The current in rotor conductors creates a magnetic field around these conductors in such a way that they try to oppose the action of the stator field. ✓
- Magnetic field lines around rotor conductors weaken the stator field on one side of the conductors and strengthen the stator field on the other side of the conductors. ✓
- A magnetic force is exerted on the rotor conductors, pulling them in the direction of the rotating magnetic field. ✓
- Owing to the torque on the rotor, it starts turning faster in an attempt to reach the speed of the rotating magnetic field. ✓ (7)

6.2

For 6 poles = 6/2 ✓½

= 3✓½

Synchronous speed (n) = (60 x f) ✓½

= 60 x 50✓½

= 3 000 r.p.m✓

Rotor speed (n_r) = (1 – s) x n✓½

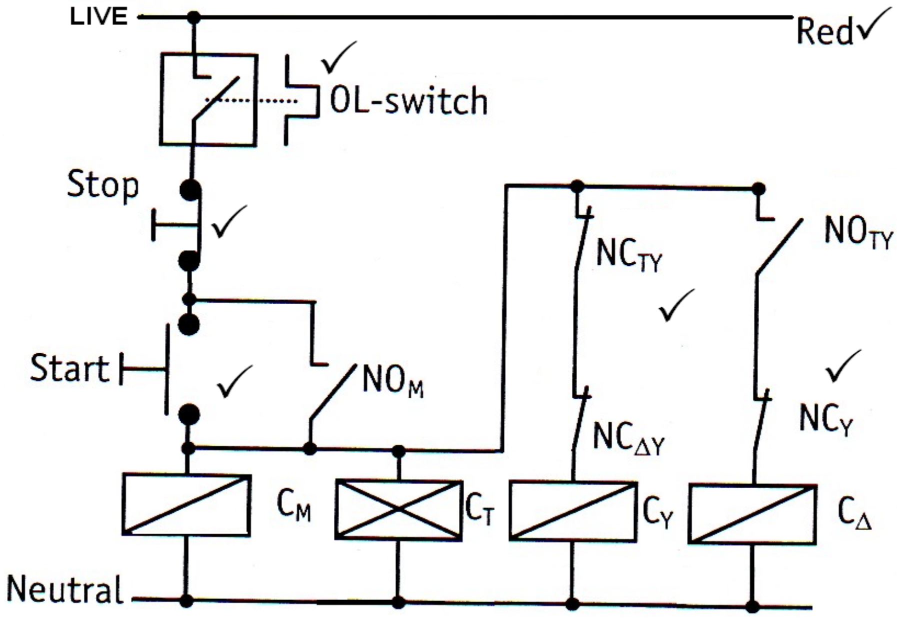
= (1 – 5/100) x 3 000✓½

= 2 850 r. p. m✓ (5)

6.3
- Those that protect electrical equipment. ✓
- Those that protect the operator. ✓ (2)

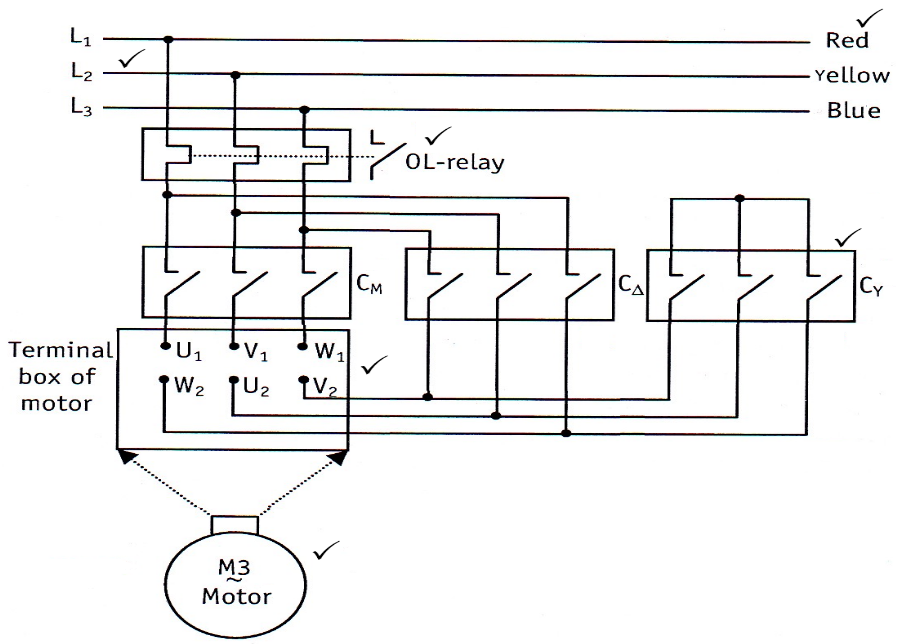
6.4
- Monitoring the steady operating conditions. ✓
- Controlling the starting current of the motor. ✓
- Controlling the restart of the motor after a power interruption. ✓ (3)

6.5 6.5.1



(6)

6.5.2



(6)

6.6 6.6.1 $P_t = P_1 + P_2$✓½

$= 1\ 200 + 2\ 300$✓½

$= 3\ 500$ W or 3,5 kW✓ (2)

6.6.2 Power factor = cos θ✓½

$$\text{POWER FACTOR} = \frac{1}{\sqrt{1 + \left[\frac{3(P_2 - P_1)}{P_1 + P_2}\right]^2}} \checkmark ½$$

$$\text{POWER FACTOR} = \frac{1}{\sqrt{1 + \left[\frac{3(2\,300 - 1\,200)}{1\,200 + 2\,300}\right]^2}} \checkmark$$

= **0,728** ✓**lagging**✓ (4)

6.6.3 The line current = $\frac{P_T}{\sqrt{3} \times V_L \times \cos\theta}$ ✓½

$= \frac{3\,500}{\sqrt{3} \times 400 \times 0{,}728}$ ✓½

= 6, 939 Amps✓ (2)

6.7
- Copper losses ✓
- Iron losses ✓
- Mechanical losses ✓

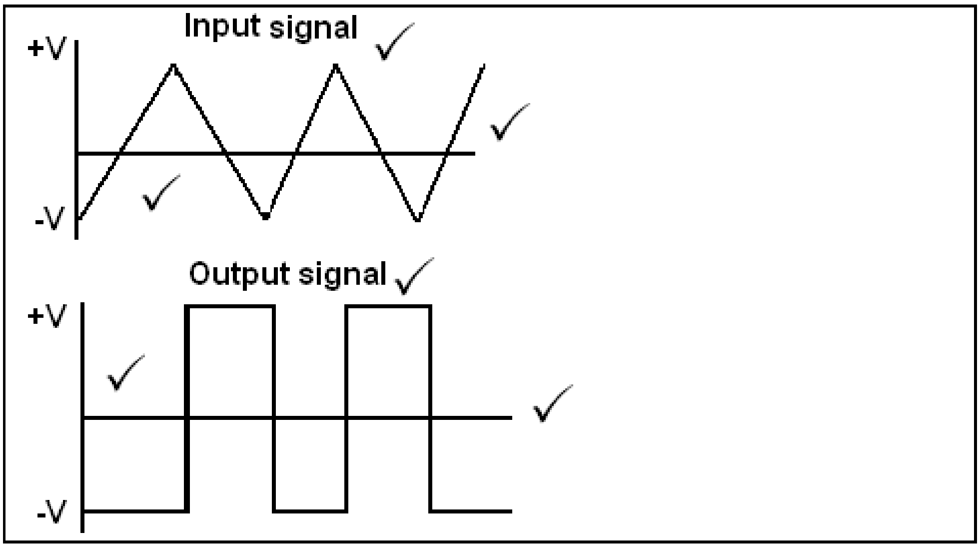
(3)

[40]

QUESTION 7: OPERATIONAL AMPLIFIERS

7.1 7.1.1 Differentiator. (1)

7.1.2



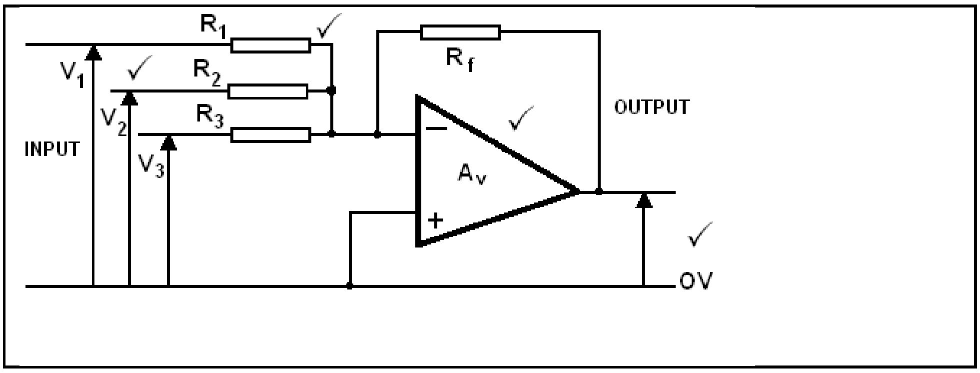
(6)

7.2 7.2.1 Integrator (1)

7.2.2 The input of a differential op-amp is a triangular wave whereas the input of an integrator is a square wave. ✓✓ (2)

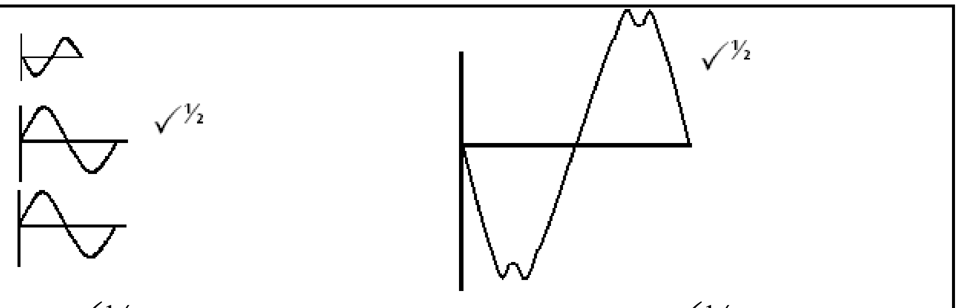
7.3 7.3.1 The inverting amplifier is often used as a mixer in audio circuit✓ when more than one signal is applied to the input simultaneously.✓ Then output becomes the sum of these input signals. ✓ **(3)**

7.3.2



(4)

7.3.3



Input ✓½ Output✓½ (4)

7.4 7.4.1 $\frac{Rf}{R1} = \alpha$

$\frac{Rf}{R1} = 10$ ✓½

$R_1 = \frac{Rf}{10}$ ✓½

$= \frac{2 \times 10^3}{10}$ ✓½

= 200 Ω✓½ (2)

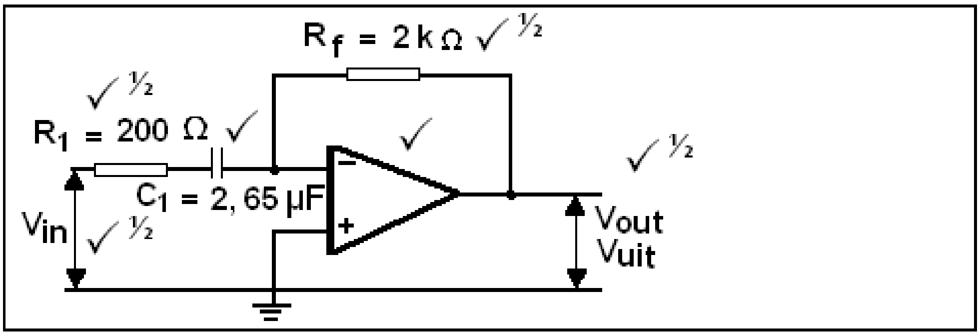
7.4.2 $f_c = \frac{1}{2\pi R1C1}$✓½

$C_1 = \frac{1}{2\pi R1\, fc}$✓½

$= \frac{1}{2\pi \times 200 \times 300}$✓½

= 2, 65 μF✓½ (3)

7.4.3



(4)

7.5 7.5.1 Positive feedback: When the output of the circuit is fed back to the input of the same circuit in phase with the input signal, the resultant will be ever increasing output. The result will be distortion or overloading of the circuit. ✓✓ (2)

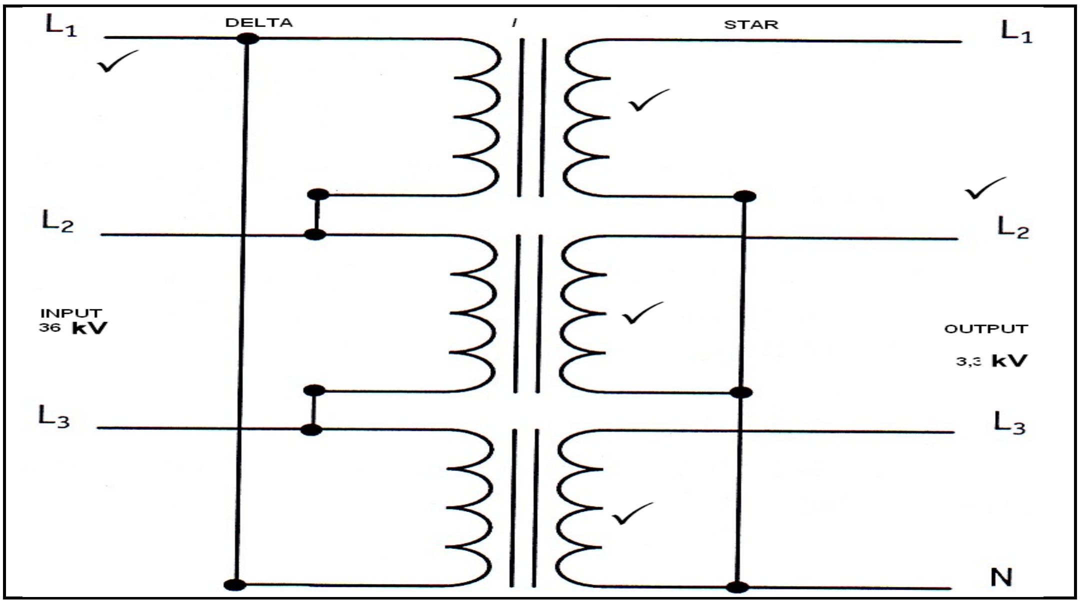
7.5.2 Negative feedback: When the output of a circuit is fed back to the input of the same circuit out of phase with the input, the result is that the output signal become smaller and may even disappear.✓ ✓ (2)

[35]

QUESTION 8: THREE-PHASE TRANSFORMERS

8.1 The principle of single-phase transformer is the same for three-phase transformer, ✓the only difference is that three single-phase transformer are used. ✓ When ac voltage is applied to the primary windings and produces a changing magnetic field which passes through to the secondary windings✓ and induces an alternating emf in them. ✓
This emf will be determined by the number of windings in the secondary side. ✓ (5)

8.2



(5)

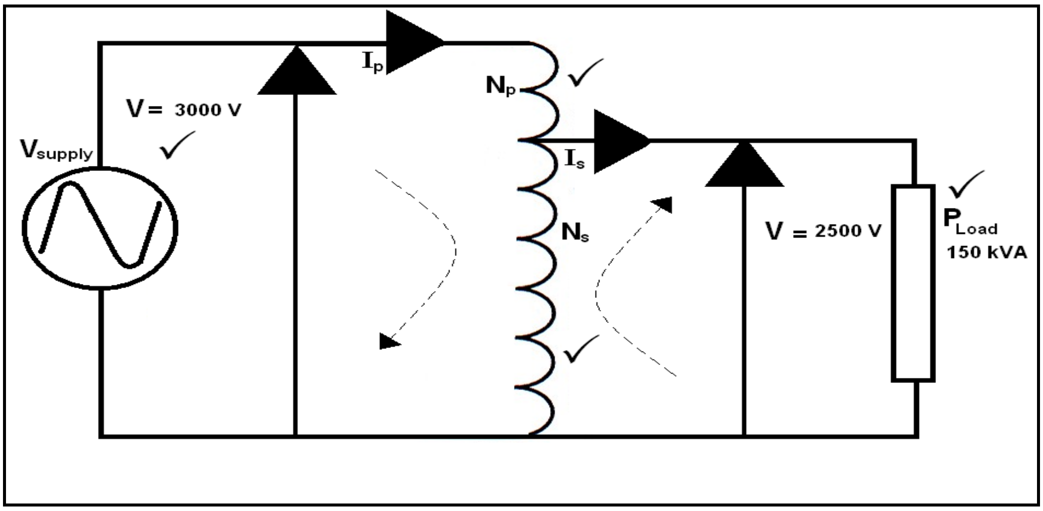
8.3 Dielectric: The copper wire that is used to form a coil is coated with a thin lacquer to insulate the turn from each other.✓ If this insulation is damaged, ✓ it will allow the leakage current to flow.✓ These losses mainly occur in high voltage transformers. ✓ (4)

8.4 8.4.1 Delta / delta this configuration is used in large-low- high voltage application. ✓ (1)

8.4.2 Delta / star this configuration is used in transmission systems. ✓ (1)

8.4.3 Star / star this configuration is used in small high-voltage application.✓ (1)

8.5



(4)

8.6 P_{IN} = 10 kW; P_{out} = 8 kW

P_{loss} =? And efficiency (ђ) =?

P_{loss} = input power – output power✓½

= 10 000 – 8 000✓½

= 2 000 kW✓

efficiency (ђ) = $\frac{\text{output power}}{\text{input power}}$ X 100% ✓½

= $\frac{8\,000}{10\,000}$ x 100% ✓½

= 80%✓

(4)

[25]

TOTAL: 200