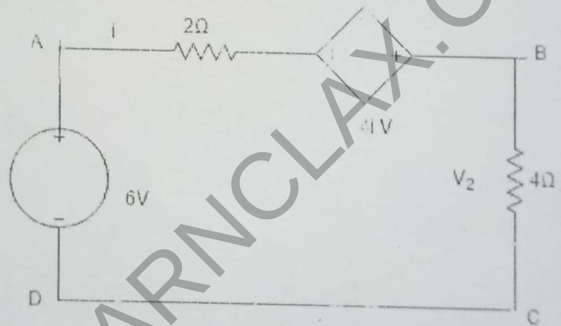
FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

ELECTRICAL/ELECTRONIC ENGINEERING DEPARTMENT

ENG 226 TEST2017/2018 Rain Semester TIME: 1:30HR

INSTRUCTION: Answer ALL Questions.

1(a).What is the distance of separation between two electrons in (i)Vacuum(ii) medium with $\varepsilon_r = 5$ for which the electric force between them is equal to the gravitational force on one of them at the earth surface? (mass of electron = $9.1\times10^{-31}\,Kg$. Charge of electron = $1.6\times10^{-19}\,C$)(b). Apply Kirchhoff's Voltage Law to find the value of current i and the voltage drops V_1 and V_2 in the circuit shown .



2(a). State the quantities to be modeled in a transformer (b) using an ideal transformer schematic diagram, obtain a practical transformer equivalent circuit. (c) From the practical transformer equivalent circuit, derive the referred value equivalent circuit.

3(a).Define transient phenomenon (b) state 3 basic equations of transient (c) Give 2 important lessons you got from studying transient

4(a) Convert 4057_8 to binary (b)Convert 10101001101011 to hex (c)Show the truth table,symbols and Boolean expressions for (i)a 3 input NAND gate (ii)a 3 input NOR gate. (d)A monostable, multi vibrator has the value of R = 1.2kΩ and C =0.1μF. Determine the time 'T' for which the circuit is on.

FEDERAL UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING & ENGINEERING TECHNOLOGY

ELECTRICAL & ELECTRONIC ENGINEERIN DEPARTMENT

2014/215 RAIN SEMESTER EXAMINATION

Introduction to Electrical & Electronic Engineering: ENG 226 (3Units)

Instructions: Answer Question 1 and any other four: **Time Allowed 3 Hours**

(1)(a) State De Morgan's Law

(b) Write the complete expression for the Minterm designation

(c) Simplify and implement $Z = (E+F)(E+\overline{EF})G + \bar{E}(\bar{F}+\bar{G}) + \bar{E}F + \overline{EFG}$

(d) Define the term resonance and state the two conditions under which it occurs?

(e) The formulae for computing resonance frequency is ....

(f) One practical application of resonance in hospital or engineering firm is ......

(g) The quantities to be modeled in a transformer are ......

(h) One major difference between an electric motor and a generator is ....

i) State Kirchhoff's current and voltage laws

(j) Current flowing across a capacitor in a transient circuit is calculated using....

2(a) What are the tools for understanding digital logic gates

(b) (i) Draw a two input OR gate symbol and write out its Boolean expression.

(ii) Represent an OR function by a switch analogy

(c) (i) Write out the correct Boolean expression for the truth Table I shown in the next page.

(ii) What is the name given to the gate that has this expression?

(iii) Draw the symbol of this gate.

(iv) Show another way of writing this expression

3(a) Analyze the role a transformer plays in bringing AC voltage to your home from the generation station.

(b) With the aid of electromagnetic laws, describe the transformer action.

(c) Draw a well labeled transformer action.

(d) A 400kVA, 11kV/415V, 50Hz transformer has 80 turns on the secondary, Calculate:

(i) Primary and secondary currents

(ii) Number of primary turns (to the nearest whole number)

(iii) The maximum flux.

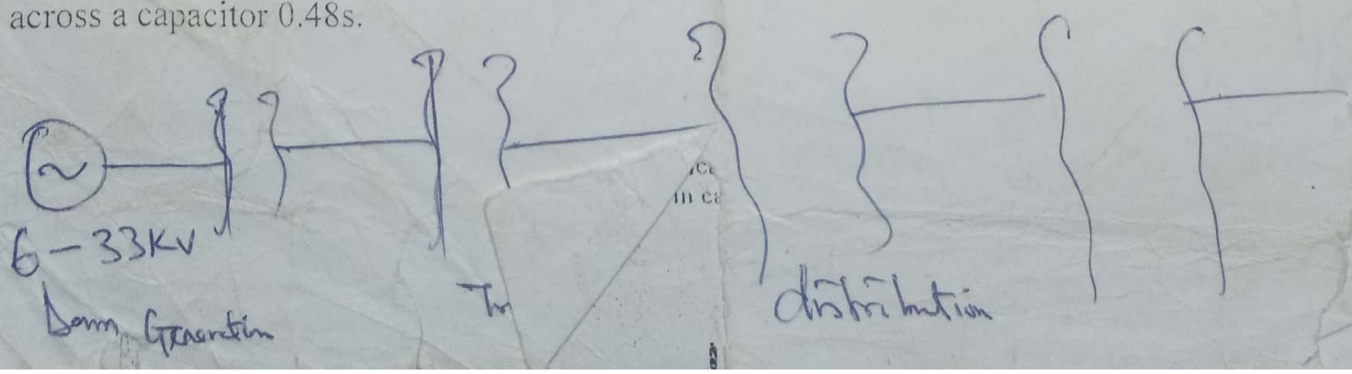
4(a)(i) With appropriate circuitry, explain what you understand by transient

(ii) State five relevancies of its study to you.

(b) Using a series RC circuit, determine the differential equation for capacitor current and voltage.

(c) State the capacitor voltage equations for charging and discharging of capacitor as transient examples.

(d) For a 2.4V supply and time constant of 0.45, compute the level of voltage that will build across a capacitor 0.48s.



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FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
RAIN SEMESTER OF 2013/2014 SESSION EXAMINATION
ENG 226: INTRODUCTION TO ELECTRICAL & ELECTRONIC ENGINEERING

INSTRUCTIONS: Attempt five questions, and at least one from each section. You must also attempt the practical check question at the end of this question paper. Time: 3Hrs.

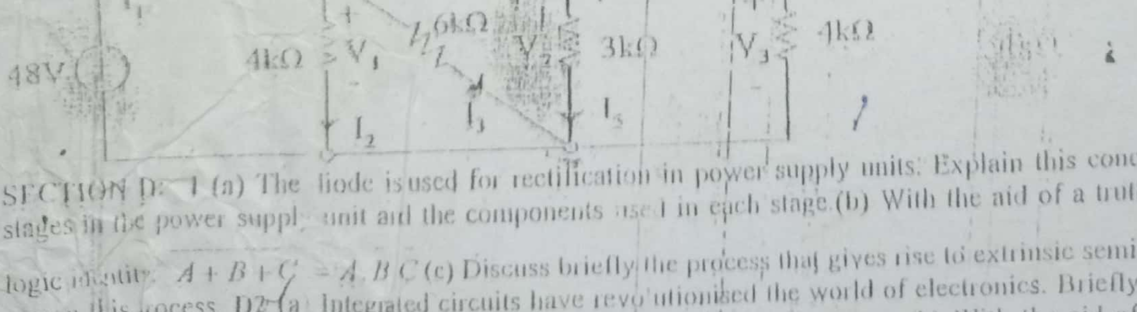
SECTION A. 1 (a) (i) Explain the concept you studied in ENG 226 that may enable you to tune your home radio to a preferred radio station. (ii) State the conditions that make this possible and develop the governing equation for the requisite frequency. (iii) Explain the varying parameters that enable you to change to different stations. (b) Given that a typical simplified circuit contains parallel combination of Capacitor of unknown value and 50mH inductor connected in series with a 2000Ω Resistor and supply voltage of 24Cps100t. Compute (i) Capacitor value for which the concept in A1(a) (i) to take place (ii) Reactance and Impedances in parallel & main circuits (iii) Total circuit current.

A2 (a) Briefly discuss with relevant circuit, the phenomenon that takes place in either of the following (i) Flight take-off (ii) When you accidentally step on hot object or (iii) Start a generator (b) State the fundamental equations for A2(a), and from these develop final voltage & current equation (c) A voltage pulse of amplitude 5V and duration 5mS is applied to a relay coil of inductance 0.1H and resistance of 100Ω. The relay contact closes at current of 40mA and open at 15mA. Given that time constant is L/R, given that t1 & t2 are time delay for closing & opening of relay respectively, according to 2(a & b), compute the lag between t1 & t2.

SECTION B: 1(a) An electricity consumer in Owerri may enjoy power generated in faraway Kainji Dam. Discuss the critical role played by transformers in transporting the electricity from generation plants to our homes.(b). The distribution transformer around your neighbourhood is rated at 400kVA, 6600V/400V, 50Hz single-phase with 40 turns in the secondary. The transformer has a primary resistance and leakage inductance of 0.44Ω and 0.02mH while the secondary resistance and leakage inductance are 0.00[illegible]Ω and 0.00[illegible]mH, respectively. Assuming E_1 is 6000V, R_c is 0.5% of primary resistance, X_m is 0.10% of primary leakage inductance, with the aid of diagrams, obtain the referred value equivalent circuit from the practical equivalent circuit. (HINT: Compute I_1, I_2, N_1, E_2, R_c, X_m) B2(a). Consider the construction of a DC machine, using appropriate diagrams and equations distinguish between the 2 types of rotating machines.(b). A client purchased a new shunt generator with a terminal voltage of 240V, and an armature resistance of 0.4Ω, a field resistance of 60Ω and is supplying a load current of 45A. The customer desires that you help with the evaluation of the generator efficiency. Assuming a rotational loss of 400W, kindly satisfy your client's desire of evaluating the efficiency. Comment on the efficiency. (HINT: Compute the field current, armature current, losses, efficiency).

SECTION C: 1 (a) By applying Gauss's law and other relevant mathematical expressions, show that the capacitance of a parallel plate capacitor in a medium is given by $C = (\varepsilon_0 \varepsilon_r A)/d$ (b) The capacitance of a capacitor formed of two metal plates each 200 cm^2 in area separated by a dielectric 4 mm thick is 0.0004 micro Farads. A potential difference of 20,000 V is applied. Calculate (i) The total charge on the plates (ii) the potential gradient (iii) the electric flux density and (iv) the relative permittivity of the dielectric. C2. Find all the currents and voltages in the network shown below. Hint: First find the total resistance seen by the source, use it to find I_1 and then apply Ohms's law, KCL, KVL, CDR and VDR to determine the remaining unknown quantities.

I = V/R



SECTION D: 1 (a) The diode is used for rectification in power supply units. Explain this concept and list other stages in the power supply unit and the components used in each stage.(b) With the aid of a truth table, prove the logic identity $\overline{A+B+C} = \bar{A}.\bar{B}.\bar{C}$ (c) Discuss briefly the process that gives rise to extrinsic semi conductors & the reason it is process. D2 (a) Integrated circuits have revolutionised the world of electronics. Briefly define an IC and mention five(5)advantages it has over connections with discrete components. (b) With the aid of circuit diagrams briefly differentiate between a diode connected in reverse and forward bias. Comment briefly on the 'knee voltage'(c) certain amplifier was measured to have the following attributes: input signal 15m[illegible] [illegible]mV and a corresponding output signal of 50mA at 5V. Calculate its Power Gain in dB.

PRACTICAL CHECK: Indicate your practical group, titles of 3 experiments you did as con[illegible] lab manual, and any five components used in each of these experiments.

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

2011/2012 SESSION RAIN SEMESTER EXAMINATION

ENG 226: BASIC ELECTRICAL AND ELECTRONIC ENGINEERING ECHNOLOGY

INSTRUCTIONS: *Attempt Question 1 and any other four.* 3 Credit Units: TIME: 3 Hours

1 (a) State the title of any four experiments you carried out during this year's ENG 226 practical.

(b) Draw an electrical circuit where one switch can be used to ON/OFF one ceiling fan and bulb in all the five rooms in your house, and equally allow each person to control his/her room.

(c) What is RESONANCE? Mention one real life application.

(d) If the capacitive reactance (X_C) in one of such applications is 100kΩ, compute the value of an inductor (L) which when connected in series with the capacitor in X_C will give resonance. N/B: System frequency is 50Hz and π is 3.1429.

2 (a)What is a transformer? Mention 4 types of transformers and their uses.

(b)State the major advantage of using alternating current for transmission and distribution.

(c) With the aid of diagrams and underlying equations, describe transformer action.

(d)(i)In a simple transformer equivalent circuit, mention the quantities to be modeled.

(ii)Outline how each of these quantities can be represented in the equivalent circuit.

3 (a) State Thevenin's theorem and deduce the statement parameters from it.

(b) Consider the circuit below, battery B has an e.m.f of 4V and 4Ω internal resistance and battery A has an e.m.f of 24V and internal resistance of 2Ω. The batteries are connected in parallel across a 10 Ω resistor. Calculate the current in each branch of the network using Superposition theorem.

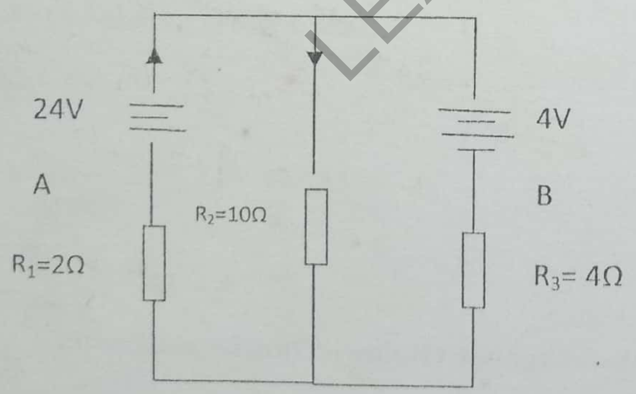


Fig. Q3b

4. (a) With examples, explain the basic difference in the characteristics and operation of (i) insulator (ii) conductor and (iii) semiconductor.

2013/2014 Answers

Section [illegible]

1, a, Resonance is a phenomenon whereby an electric cct or device produces the largest possible response to an applied oscillating signal. Resonance occur in an electric cct at a point when the overall circuit impedance is minimum.

ii, In electrical cct, Resonance occurs when inductive reactance X_L is equal in magnitude to capacitive reactance X_C i.e. @ $X_L = X_C$ so dat overall impedance $Z = \sqrt{R^2 + (X_L - X_C)^2}$ where $|X_L| = |X_C|$

$\Rightarrow Z = \sqrt{R^2} = R \longrightarrow$ point of minimum impedance

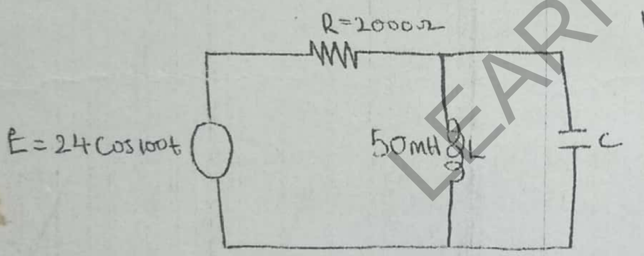
Resonance Frequency F_R

Since $X_L = X_C$ at resonance and $X_L = 2\pi f L$, $X_C = \frac{1}{2\pi f C}$

$\Rightarrow 2\pi f_R L = \frac{1}{2\pi f_R C} \Rightarrow F_R^2 = \frac{1}{(2\pi)^2 LC} \Rightarrow F_R = \frac{1}{2\pi\sqrt{LC}}$

iii Resistance, Inductance and capacitance are the varying parameters that helps to change to different stations.

b, **Cct Diagram**



By Comparison, $E = 24\cos 100t$

$\Rightarrow \omega = 100$

$\Rightarrow C = \frac{1}{100^2 \times 50 \times 10^{-3}} = 2 \times 10^{-3}$ F

or $C = 2000\ \mu F \Rightarrow$ at resonance

i, At resonance $X_L = X_C$

$\Rightarrow 2\pi f L = \frac{1}{2\pi f C}$

$C = \frac{1}{(2\pi f)^2 L}$

but $2\pi f = \omega$

$\Rightarrow C = \frac{1}{\omega^2 L}$

Note: The general form of a Sinusoidal voltage E is given by:

$E = A\cos\omega t$

where A is the amplitude

ii, $X_L = 2\pi f L = \omega L = 100 \times 50 \times 10^{-3}$

$= j5\ \Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{\omega C} = -j5\ \Omega$

The overall cct impedance Z

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

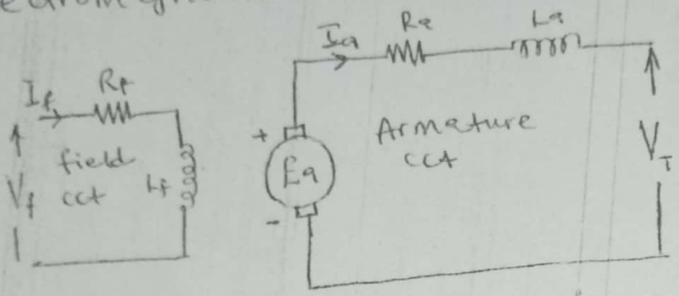
$Z = R = 2000\ \Omega$

iii, $I = \frac{E}{Z} = \frac{24\cos 100t}{2000}$

$= 0.012\cos 100t$ A

(2) a(iii) Starting of Generator

The Phenomenon that takes place is starting a generator is electromagnetic induction.



I_f = field current
R_f = " resistance
V_f = " voltage
L_f = " inductance
E_a = induced emf
V_T = Terminal voltage
L_a = armature inductance
R_a = " resistance
I_a = " current

Starting a generator

A dc voltage source is applied to the field winding and by Faraday's law, the current flowing thru the winding produces a magnetic field around it. External rotational force is applied to rotate the produced magnetic field. The now rotating magnetic field will be cutting across the armature winding and by Lenz's Law, emf is induced in the armature winding. The terminal voltage is the voltage seen at the generator terminal after drops on the armature resistance and reactance respectively

b) Fundamental equations

Applying KVL round the armature loop, we have

$$E_a = I_aR_a + L_a\frac{di_a(t)}{dt} + V_T \quad ----- (1)$$

OR $$V_T = E_a - I_aR_a - L_a\frac{di_a(t)}{dt} \quad ----- \text{Voltage equation}$$

Also from (1)

$$E_a - V_T = I_aR_a + L_a\frac{di_a(t)}{dt} \quad --- (2)$$

Laplace transforming ② gives

$$E_{a(s)} - V_{T(s)} = I_{a(s)} R_a + s L_a I_{a(s)} = I_{a(s)} (R_a + sL)$$

$$\Rightarrow I_{a(s)} = \frac{E_{a(s)} - V_{T(s)}}{(R_a + s L_a)}$$. where s indicates complex plane

$$I_{a(s)} = \frac{(E_{a(s)} - V_{T(s)})/L}{\left(s + \frac{R_a}{L_a}\right)}$$ ~~but~~ $\frac{R_a}{L_a} = \frac{1}{T_a}$ where T_a is RL cct time constant

$$= \frac{(E_{a(s)} - V_{T(s)})/L}{\left(s + \frac{1}{T_a}\right)}$$

Inverse Laplace transforming gives

$$i_{(t)} = \left(\frac{E_a - V_T}{L}\right) e^{-\frac{t}{T_a}}$$ - - - - Current equation

SECTION B:

① a, Role of transformer in transporting electricity from the generating stations to our homes.

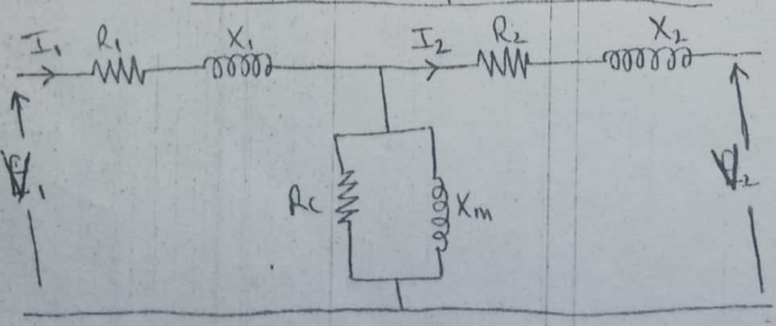
Transformer is an electromagnetic machine that serves the purpose of converting electrical parameters (Voltage, current etc) from one level to another.
A generating stations, power is generated at low voltages of about 10.5kV, 11.5kV, 15.5kV etc. Transmitting at this low voltage will amount to very huge power loss, hence, transformers are required to enable step up the voltage high enough to limit the power loss. Transmission is done at 330 kV (Primary transmission) or 132 kV (secondary transmission). The transformer is needed to step up the generated voltage to as high as the desired transmission voltage.
At the distribution end, transformers are required to step down the transmission voltage to a distribution voltage level of 33 kV or 11 kV. At the final consumere end, the transformer also steps down the distribution voltage for domestic use (230V for single phase, 415V for 3 phase).

b) 400kVA, 6600V/400V, 50 Hz, $N_2 = 40$, single phase

$R_1 = 0.44\Omega$, $L_1 = 0.02mH$, $R_2 = 0.0022\Omega$, $L_2 = 0.001mH$

$E_1 = 6000V$, $R_C = \frac{0.5}{100} \times 0.$, $X_m = \frac{0.1}{100} \times 2\pi f L_1$

Transformer equivalent cct



$X_1 = 2\pi f L_1 =$ [illegible] $50 * 0.02\times10^{-3} = j6.28\times10^{-3}\,\Omega \simeq j0.0063\,\Omega$

$X_2 = 2\pi f L_2 = 2\pi * 50 * 0.001\times10^{-3} = j0.000314\,\Omega$

$X_m = \frac{0.1}{100} * X_1 = \frac{0.1}{100} * j0.0063 = \underline{j6.3\times10^{-6}\,\Omega}$

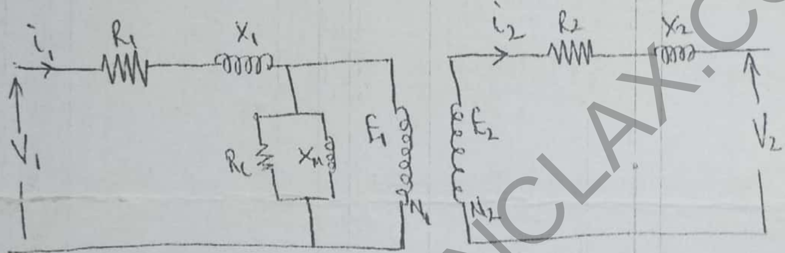
$R_c = \frac{0.5}{100} * R_1 = \frac{0.5}{100} * 0.44 = \underline{2.2\times10^{-3}\,\Omega}$

6600V/400V represents primary to secondary voltage ratio of the xfmr

and $\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1} \Rightarrow \frac{6600}{400} = \frac{N_1}{40} \Rightarrow \underline{N_1 = 660 \text{ turns}}$

Also

$\frac{E_1}{E_2} = \frac{N_1}{N_2} \Rightarrow \frac{6000}{E_2} = \frac{660}{40} \Rightarrow E_2 = \frac{6000 * 40}{660} = 363.63\,V$



Applying KVL in the above xfmr cct,

$i_1 = \frac{V_1 - E_1}{(R_1 + jX_1)} = \frac{6600 - 6000}{0.44 + j0.0063} = \frac{600}{0.44 + j0.0063} = (1{,}363.35 - j19.52)\,A$
$= 1363.5\angle -0.0143^\circ\,A$

Also

$i_2 = \frac{V_2 - E_2}{R_2 + jX_2} = \frac{400 - 363.63}{0.0022 + j0.000314} = \frac{36.37}{0.0022 + j0.000314} = (16{,}201.77 - j2312.43)\,A$
$= 16{,}366\angle -0.142^\circ\,A$

<u>For the reffered values</u>

$\rightarrow \frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1} = a$ where a = turn ratio

Note : When reffered to primary, it means the primary side terms remains constant while the secondary side terms are expressed in terms of primary side terms.

$\Rightarrow \frac{V_1}{V_2} = a \Rightarrow V_1 = aV_2$ So we replace V_2 with aV_2

$\frac{I_2}{I_1} = a \Rightarrow I_1 = \frac{I_2}{a}$ So we replase I_2 with $\frac{I_2}{a}$

$\frac{V_1}{V_2} \cdot \frac{I_2}{I_1} = a^2 = \frac{R_1}{R_2} \Rightarrow R_1 = a^2 R_2$ So we replace R_2 with $a^2 R_2$

but $a = \frac{N_1}{N_2} = \frac{660}{40} = 16.5$

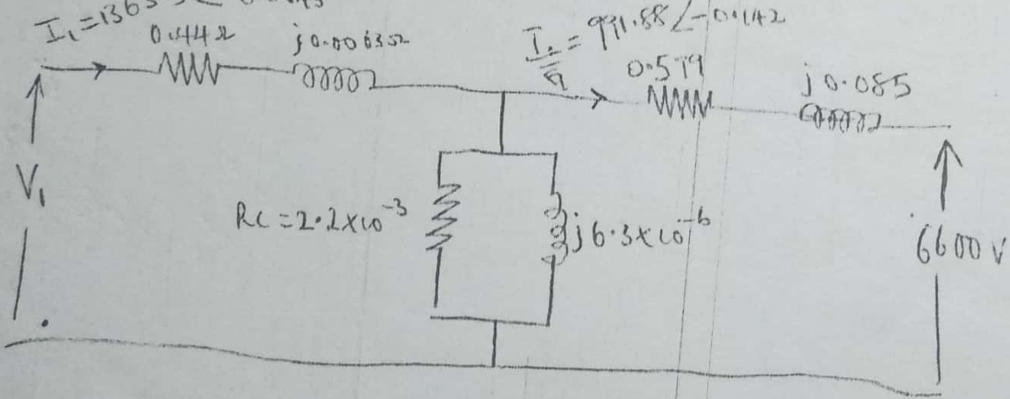
$\Rightarrow aV_2 = 16.5 \times 400V = \underline{6600\ V}$

$\frac{I_2}{a} = \frac{16366}{16.5} \angle -0.142^\circ = \underline{(991.88 \angle -0.142^\circ) A}$

$a^2 R_2 = 16.5^2 * 0.0022 = 0.599\ \Omega$

$a^2 jX_2 = 16.5^{-2} * j0.000314 = j0.085$

The transformer equivalent cct refered to the primary is therefore shown below

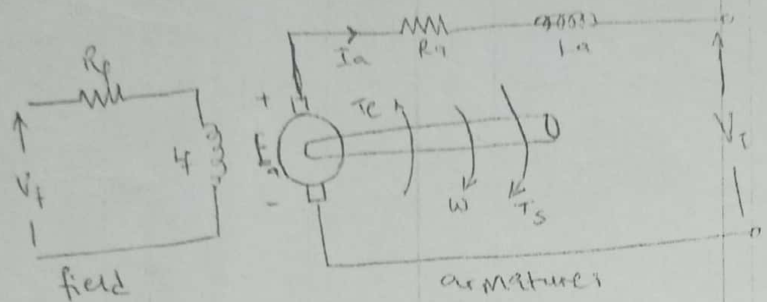


B1) a,

DC Machine Construction

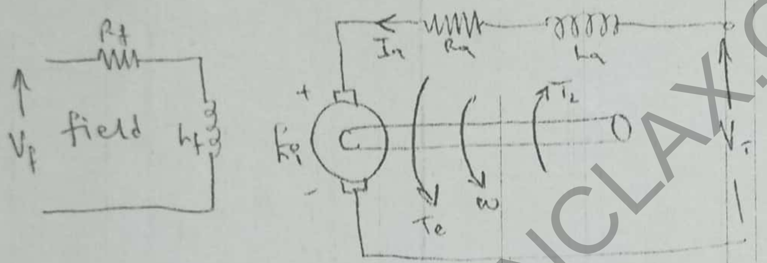
A machine can either be generator or a motor

Generator construction



Note: the cct diagram is basically the same except for current direction. In generator, current goes out while in motor, current goes in.

Motor Construction



Applying KVL in the two ccts we obtain

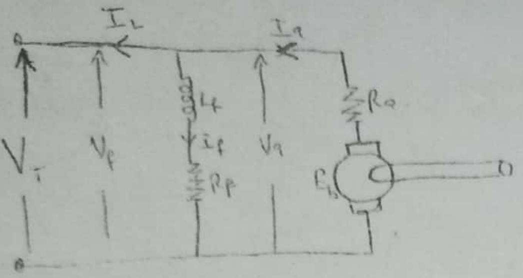
Generator equation

$$E_a = I_aR_a + L_a\frac{dI_{a(t)}}{dt} + V_t$$

Motor Equation

$$V_T = I_aR_a + L_a\frac{dI_{a(t)}}{dt} + E_a$$

The generator converts mechanical energy to electrical energy while the motor converts electrical energy to mechanical energy.



From question

$V_t = 240V$

$R_a = 0.4\Omega$

$R_f = 60\Omega$

$I_L = 45A$

$P_{rot} = 400W$

A shunt generator

From the cct diagram

$V_T = V_f = V_a = E_b - I_aR_a = 240V$

Field Current

$V_f = 240V$

$R_f = 60\Omega$

$I_f = \frac{240}{60} = 4A$

Armature current

$I_a = I_L + I_f$

$= 45 + 4$

$= 49A$

Losses

Armature loss $= I_a^2 R_a$

$= 49^2 * 0.4 = 960.4W$

Total losses

$= 960.4 + 400 = 1360.4W$

Also $E_b = 240 + I_aR_a = 240 + 49 * 0.4 = 259.6V$

Power input $= I_a E_b = 49 * 259.6 = 12,720.4W$

Efficiency $= \frac{P_{out}}{P_{in}} \times 100\%$ $\quad P_{out} = P_{in} - \text{Losses} = 12720.4 - 1360.4$

$= 11360W$

$\eta = \frac{11360}{12720} \times \frac{100}{1} = 89.3\%$

89.3% Efficiency shows the generator is moderately ok