		i) Find the equivalent circuit referred to high voltage side. ii) Calculate the full load voltage regulation at 0.8 pf lagging. iii) What is the efficiency at half the rated load at unity power factor.			
	b)	Explain the conditions in detail that must be fulfilled for the satisfactory parallel operation of two single phase transformers.	L3	CO3	5 M
OR					
9	a)	Discuss the separation of core losses in single phase transformer.	L3	CO3	5 M
	b)	Two similar 200 kVA, single phase transformers gave the following results when tested by sumpner's test: Mains Wattmeter W_1 = 4kW, series wattmeter W_2 = 6 kW at full load current. Find out individual transformer efficiencies at full load, unity power factor.	L4	CO5	5 M
UNIT-V					
10		Describe four possible ways of connections of three phase transformers with relevant relations between voltages and currents on h.v and l.v sides.	L4	CO5	10 M
OR					
11	a)	Explain the operation of on-load tap changing transformer.	L4	CO5	5 M
	b)	Discuss the parallel operation of Three phase transformers.	L4	CO5	5 M

Code: 23EE3302

II B.Tech - I Semester – Regular / Supplementary Examinations
NOVEMBER 2025

DC MACHINES AND TRANSFORMERS
(ELECTRICAL & ELECTRONICS ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	What is the purpose of Yoke? Mention materials used to make Yoke.	L2	CO1
1.b)	What is commutation? How to achieve good commutation?	L3	CO2
1.c)	What is the necessity of starter?	L3	CO2
1.d)	What are the iron losses and how to minimize it?	L4	CO4
1.e)	Define the voltage regulation of a transformer.	L3	CO3
1.f)	Define all day efficiency.	L3	CO3
1.g)	Why Iron losses neglected in short circuit test?	L3	CO3
1.h)	What is the difference between Auto transformers and two winding transformers?	L3	CO3
1.i)	What advantages do the star connection over the delta connection?	L4	CO5
1.j)	What is the purpose of tertiary winding in a three winding transformer?	L4	CO5

PART – B

			BL	CO	Max. Marks
		UNIT-I			
2	a)	Derive emf equation of dc generator.	L3	CO2	5 M
	b)	The armature of a 6-pole generator has a wave winding containing 664 conductors. Calculate the generated e.m.f when flux per pole is 60 mWb and speed is 250 r.p.m. Find the speed at which the armature must be driven to generate an e.m.f of 550V if the flux per pole is reduced to 58 mWb.	L4	CO4	5 M
		OR			
3		What is armature reaction? Describe the effects of armature reaction on the operation of dc machine. How is armature reaction minimized?	L3	CO2	10 M
		UNIT-II			
4	a)	Derive the condition for maximum efficiency of a dc motor.	L3	CO2	5 M
	b)	With neat circuit diagram explain 4 point starter.	L4	CO4	5 M
		OR			
5	a)	What are the various methods of speed control of dc motors? Explain speed control of dc series motor by any one method.	L3	CO2	5 M
	b)	Explain the principle of Hopkinson's Test.	L4	CO4	5 M

		UNIT-III			
6	a)	Derive the EMF equation of 1-Φ Transformer from the fundamentals.	L3	CO3	5 M
	b)	A 33 KVA, 2200/220 V, 50 Hz single phase transformer has the following parameters. Primary winding (h.v side): R_1 = 2.4Ω, X_1=6 Ω Secondary winding (l.v side): R_2= 0.03Ω, X_2 = 0.07Ω. i) Find the primary resistance and leakage reactance referred to secondary. ii) Find the equivalent resistance and equivalent reactance referred to secondary.	L4	CO5	5 M
		OR			
7	a)	Discuss the effect of variation of frequency and supply voltage on losses.	L3	CO3	5 M
	b)	A 25 KVA, 2200/200V, 50 Hz transformer has maximum efficiency at 80% of full load. Its equivalent resistance and impedance are 0.012 p.u and 0.05 p.u. Determine the efficiency and voltage regulation at half of full load and 0.8 pf lag.	L4	CO5	5 M
		UNIT-IV			
8	a)	A 15 kVA, 2300/230 V, 50 Hz single phase transformer gave the following test data: Open circuit test: 2300 V, 0.21A, 50W Short circuit test: 47 V, 6 A, 160 W	L4	CO5	5 M

code: 23EE3302 | PVP23

II B.Tech, I-Sem - Regular Examination - NOV-2025

DC Machines and Transformers

Scheme of Evaluation

PART-A

1) 1(a) to 1(j) Each question - 2 Marks

PART-B

UNIT-I

2 (a) Deriving average emf, e — 3M

Deriving total emf generated, E_g — 2M

(b) calculating generated emf — 3M

calculating speed (in second case) — 2M.

3 what is armature reaction — 2M

Diagrams of armature reaction — 3M

Explanation of armature reaction — 3M

How is armature reaction minimized — 2M

UNIT-II

4 (a) Deriving equation upto efficiency — 3M

Deriving condition for max. efficiency — 2M

4 (b) Diagram of 4 Point starter — 3M

explanation of 4 Point starter — 2M

5 (a) Explanation of various methods of speed control — 2M

*Any one method of speed control of d.c series motor } 3M

5 (b) Diagram of Hopkinson's test — 2M

Explanation of Hopkinson's test — 3M

6 (a) Deriving upto instantaneous emf — 3M

Deriving rms value of emf — 2M

6 (b) calculating Transformation ratio, K — 1M

" Pr. resistance ref. to sec, R_1' — 1M

" Pr. reactance " " , X_1' — 1M

" Eq. resistance " " " , R_{02} — 1M

" Eq. reactance " " , X_{02} — 1M

7(a) Equations of P_h & P_e — 2M

Explation of effect of variation f & V — 3M

7(b) calculating efficiency — 3M

calculating voltage regulation — 2M

8(a) Finding equivalent circuit parameters — 2M

calculating voltage regulation — 1M

calculating efficiency — 2M

8(b) Conditions for satisfactory parallel operation of two 1ϕ T/F's } 5M

9(a) Equations of P_h & P_e — 2M

explanation of separation of core losses — 3M

9(b) calculating losses — 2M

calculating efficiency — 3M

10) Star - Star connection — 3M

Delta - Delta connection — 3M

Star - Delta connection — 2M

Delta - Star connection — 2M

11(a) Diagram of on load tap changing T/F — 3M

Explanation of operation of on load tap changing T/F } — 2M

11(b) condition for parallel operation of three phase transformer } 5M.

Code: 23EE3302 PVP23

II B.Tech - I Sem - Regular Examination - NOV-2025

DC Machines and Transformers

PART-A

1(a) What is the purpose of Yoke? Mention materials used to make Yoke

Ans ⇒ Yoke acts as a frame (protecting cover) for the machine and carries the magnetic flux produced by poles.

⇒ Yoke is made of cast iron & cast steel

1 b) What is commutation? How to achieve good Commutation?

Ans ⇒ The reversal of current in a coil as the coil passes the brush axis is called commutation.

⇒ Interpoles are used to achieve good commutation.

1 c) What is the necessity of Starter?

Ans A starter is necessary to limit high starting current.

1 d) What are the iron losses and how to minimize it?

Ans ⇒ Iron losses consists of hysteresis and eddy current losses

⇒ In order to minimize hysteresis loss, armature core is made of such materials which have a low value of hysteresis coefficient

⇒ Eddy current loss is minimized by using laminated core.

1(e) Define the voltage regulation of a transformer.

Ans The change in secondary terminal voltage from no load to full load, expressed as a percentage of secondary terminal voltage at no load.

(OR) $\% V.R = \left[\frac{E_2 - V_2}{E_2}\right] 100$

1f Define all day efficiency

Ans It is the ratio of the total energy output in kwh during 24 hour period to the the total energy input in kwh during 24 hour period.

1g why Iron losses neglected in short circuit test?

Ans In s/c test, the transformer is supplied with a very low voltage to circulate current. This low voltage produces a small flux, core loss depends on flux, which is very small and hence Iron loss neglected.

1h. what is the difference between Auto transformers and two winding transformers?

Ans 1) In auto T/F number of winding is one, two winding T/F two

2) The size of auto T/F is small as compared to two winding T/F

3) In auto T/F copper saving is more as compared to two wdg T/F

4) In auto T/F losses is low, two winding T/F is high

5) In auto T/F efficiency is high, two winding T/F is low

6) cost of auto T/F is less, two winding T/F is more

$\boxed{\text{Any two above Comparision}}$

(i) 1i what advantages do the star connection over the delta connection?

Ans Advantage of star connection over delta connection.

→ Neutral point is available for using both 1ϕ & 3ϕ loads

→ phase voltage is lower than line voltage ($V_{ph} = \frac{V_L}{\sqrt{3}}$), which reduce insulation requirements.

1j) what is the purpose of tertiary winding in a 3ϕ T/F?

Ans. Tertiary winding provide a path for third harmonic currents there by improving the waveforms of the voltage.

PART- B

UNIT- I

2(a) Derive emf equation of dc generator.

Let P = No. of poles, ϕ = flux/pole, N = speed in rpm

Z = Total no. of conductors

A = No. of parallel paths

⇒ Average emf induced in each conductor, $e = \frac{d\phi}{dt}$

- Flux cut by one conductor in one revolution, $d\phi = P\phi$
- Time taken to complete one revolution $dt = \frac{60}{N}$

$$e = \frac{d\phi}{dt} = \frac{P\phi N}{60}$$

- There are Z conductors in A number of parallel paths, hence $\frac{Z}{A}$ number of conductors are in series.
- Total emf of generator, $E_g = \frac{P\phi N}{60} \frac{Z}{A}$

$$E_g = \frac{\phi Z N}{60}\left(\frac{P}{A}\right)$$

2(b) $P = 6$, $Z = 664$, $\phi = 60 \times 10^{-3}$ wb, $N = 250$ rpm

$$E_g = \frac{\phi Z N}{60}\left(\frac{P}{A}\right) = \frac{(60\times10^{-3})(664)(250)}{60}\left(\frac{6}{2}\right) = 498$$

$N = ?$, $E_g = 550V$, $\phi = 58\times10^{-3}$ wb

$$E_g = \left(\frac{\phi Z N}{60}\right)\left(\frac{P}{A}\right)$$

$$550 = \frac{(58\times10^{-3})\times(664)\ N}{60}\left(\frac{6}{2}\right)$$

$N = 285.6$ rpm

≈ 286 rpm

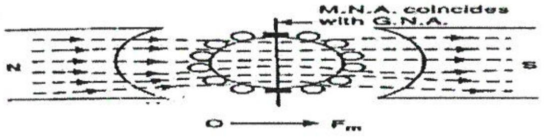
3. What is armature reaction? Describe the effects of armature reaction on the operation of dc machines. How is armature reaction minimized?

Ans: The action of armature flux on the main flux is known as armature reaction.
The armature reaction produces the following two effects:
1. It demagnetizes or weakens the main flux.
2. It cross-magnetizes or distorts the main flux.
Let us discuss these effects of armature reaction by considering a 2-pole generator.
(I) Fig. (i) shows the flux due to main poles (main flux) when the armature conductors carry no current. The flux across the air gap is uniform. The m.m.f. producing the main flux is represented in magnitude and direction by the vector OF_m in Fig. (i). Note that OFm is perpendicular to G.N.A.
(II) Fig. (ii) shows the flux due to current flowing in armature conductors alone (main poles unexcited). The armature conductors to the left of G.N.A. carry current "in" (x) and those to the right carry current "out" (•). The direction of magnetic lines of force can be found by cork screw rule. It is clear that armature flux is directed downward parallel to the brush axis. The m.m.f. producing the armature flux is represented in magnitude and direction by the vector OF_A in Fig. (ii).
(III) Fig. (iii) shows the flux due to the main poles and that due to current in armature conductors acting together. The resultant m.m.f. OF is the vector sum of OF_m and OF_A as shown in Fig. (iii). Since M.N.A. is always perpendicular to the resultant m.m.f., the M.N.A. is shifted through an angle θ. Note that M.N.A. is shifted in the direction of rotation of the generator.
(IV) In order to achieve sparkless commutation, the brushes must lie along the M.N.A. Consequently, the brushes are shifted through an angle θ so as to lie along the new M.N.A. as shown in Fig. (iv). Due to brush shift, the m.m.f. F_A of the armature is also rotated through the same angle θ. It is because some of the conductors which were earlier under N-pole now come under S-pole and vice-versa. The result is that armature m.m.f. F_A will no longer be vertically downward but will be rotated in the direction of rotation through an angle θ as shown in Fig.(iv).

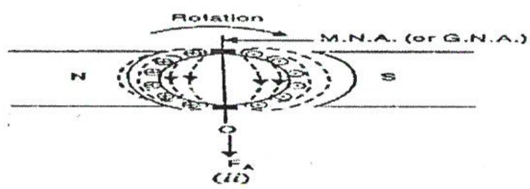
Now F_A can be resolved into rectangular components F_c and F_d.

(a) The component Fd is in direct opposition to the m.m.f. OFm due to main poles. It has a demagnetizing effect on the flux due to main poles. For this reason, it is called the demagnetizing or weakening component of armature reaction.

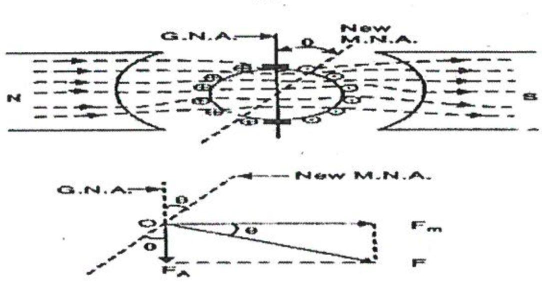
(b) The component Fc is at right angles to the m.m.f. OFm due to main poles. It distorts the main field. For this reason, it is called the cross magnetizing or distorting component of armature reaction.



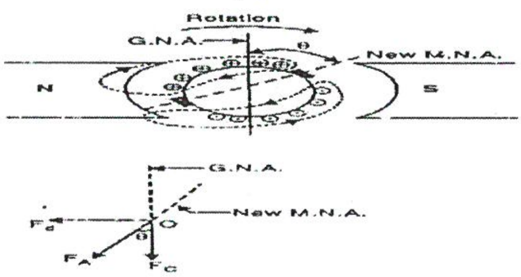
(i)



(ii)



(iii)



(iv)

Demagnetizing effect: Demagnetizing effect of armature reaction can be neutralized by putting extra turns on each pole of the generator.
Cross-magnetizing effect: In order to neutralize the cross-magnetizing effect of armature reaction, a compensating winding is used.

UNIT-II

4(a) Derive the condition for maximum efficiency of a dc motor.

Ans: Condition for maximum efficiency of a dc generator & of a dc motor is the same. Considering dc generator

⇒ Generator output $= VI_L$ watts

Generator input = output + Total losses

$$= VI_L + I_a^2 R_a + P_c$$

$$= VI_L + (I_L + I_{sh})^2 R_a + P_c$$

$$= VI_L + I_L^2 R_a + P_c \quad (\text{As } I_{sh} \text{ is very small})$$

Gen efficiency $\eta = \dfrac{o/p}{i/p} = \dfrac{VI_L}{VI_L + I_L^2 R_a + P_c} = \dfrac{1}{1 + \dfrac{I_L R_a}{V} + \dfrac{P_c}{VI_L}}$

Efficiency will be maximum when denominator will be minimum.

$$\frac{d}{dI_L}\left(\frac{I_L R_a}{V} + \frac{P_c}{VI_L}\right) = 0$$

$$\Rightarrow \boxed{I_L^2 R_a = P_c}$$

(OR)

⇒ Considering dc motor

Motor input $= VI_L$

Motor output = Input − Total losses

$$= VI_L - I_a^2 R_a - P_c$$

$$= VI_L - I_L^2 R_a - P_c \quad (\text{As } I_{sh} \text{ is very small})$$

Motor efficiency, $\eta = \dfrac{o/p}{i/p} = \dfrac{VI_L - I_L^2 R_a - P_c}{VI_L} \Rightarrow 1 - \dfrac{I_L R_a}{V} - \dfrac{P_c}{VI_L}$

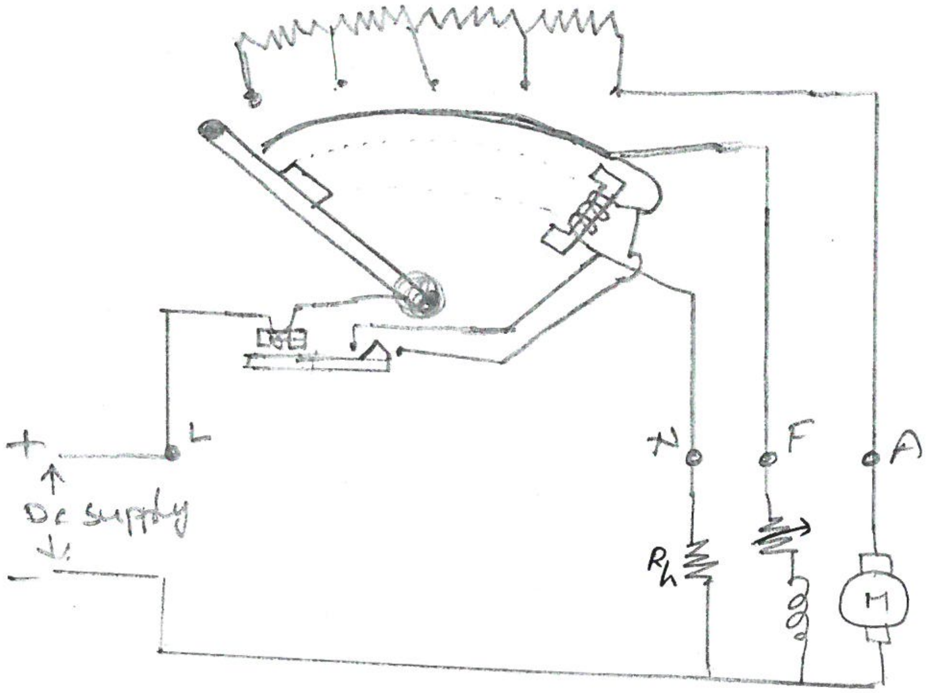
Efficiency is maximum; $\dfrac{d}{dI_L}\left(1 - \dfrac{I_L R_a}{V} - \dfrac{P_c}{VI_L}\right)$

$$\Rightarrow \boxed{I_L^2 R_a = P_c}$$

Efficiency is maximum when variable losses are equal to constant losses

4(b) with neat circuit diagram explain 4 point starter ⑥

Ans-



⇒ Figure shows the schematic diagram of a 4-Point Starter.

- The starter consists of starting resistance divided into several sections and connected in series with armature.
- The Four terminals L, N, F & A are connected respectively to the positive line terminal, protective resistance R_h, shunt field terminal and armature.
- The no volt release coil & over load release coil are respectively connected to line and field circuits.
- As the handle is moved over to the studs, starting resistance is cut out and soft iron piece attached to the handle is held magnetically by the no volt release coil
- No volt release coil protects machine, in case of failure of supply
- over load release coil protects machine under over loaded condition.
- Since the no volt release coil is independent of shunt field circuit, it will not be affected by the change of the current in the shunt field current.

5(a) What are the various methods of speed control of dc motors? Explain speed control of dc series motor by any one method.

Ans:- Various methods of speed control of dc motor are

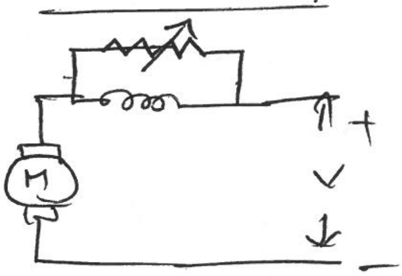
(1) Flux control method (2) Armature control method.

(1) Flux control method: By varying the flux ϕ, the motor speed ($N \propto \frac{1}{\phi}$) can be changed.

(2) Armature control method: By varying the voltage across the armature, the speed of the motor can be changed.

DC series:- * $\boxed{\text{Note: Any one method}}$

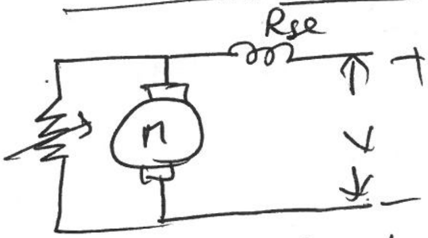
(i) Field diverter :-



- The series winding are shunted by a variable resistance
- Any desired amount of current can be passed through the diverter by adjusting its resistance.
- Hence the flux can be decreased and speed of the motor increased.

(OR)

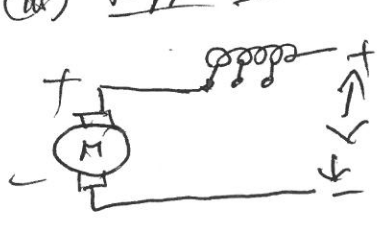
(ii) Armature diverter :-



- A diverter across the armature used for giving speeds lower than the normal speed.
- If I_a is reduced, ϕ must increase, thus fall in speed.

(OR)

(iii) Tapped field control :-

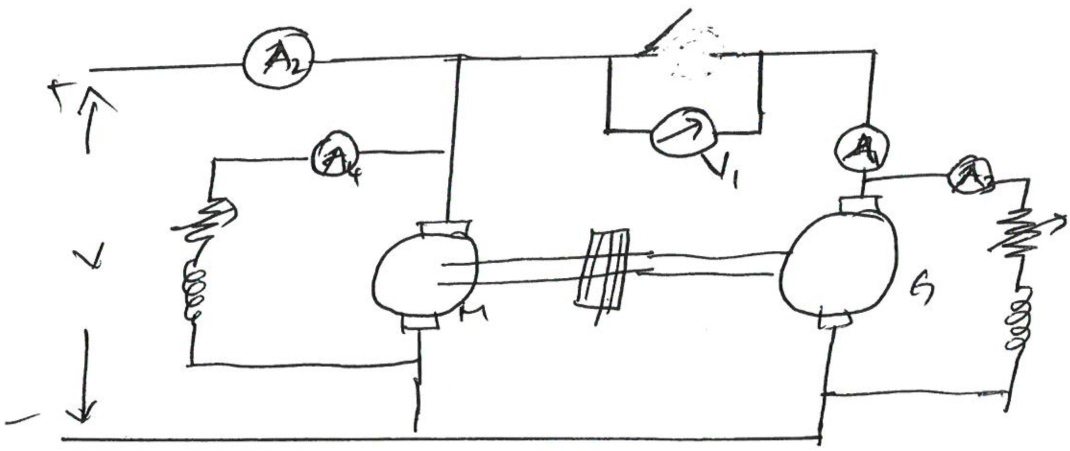


- The number of series field turns in the circuit can be changed at will as shown.
- Motor speed can changed in steps.

5(b) Explain the principle of Hopkinson's test.

Ans: Hopkinsons test :-

- Two identical d-c shunt machines are mechanically coupled and connected in parallel across the d-c supply.
- By adjusting the field excitations of the machines, one is run as motor and the other as a generator.
- The electric power from the generator and electrical power from the d-c supply are fed to the motor.
- The mechanical power from motor is given to the generator.
- Thus the electrical power taken from the dc supply is the sum of motor and generator losses.
- By adjusting the field strengths of machines, any load can be put on the machines.
- ∴, it can measure total loss of the machines at any load.
- Thus, efficiency of the machines can be found.



UNIT-III

6(a) Derive the emf equation of 1-ϕ Transformer from the fundamentals.

Ans- Let alternating voltage V_1 of frequency f is applied to the primary winding of a transformer.

- Thus, Sinusoidal flux ϕ produced, $\phi = \phi_m \sin \omega t$.
- instantaneous emf induced, $e_1 = -N_1 \frac{d\phi}{dt}$

$$= -N_1 \frac{d}{dt}(\phi_m \sin \omega t)$$

$$= -\omega N_1 \phi_m \cos\omega t = -2\pi f N_1 \phi_m \cos\omega t$$

$$= 2\pi f N_1 \phi_m \sin(\omega t - 90^\circ)$$

- Maximum value of induced emf; $E_{m_1} = 2\pi f N_1 \phi_m$
- Rms Value of $E_1 = \frac{E_{m_1}}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}}$

$$E_1 = 4.44 f N_1 \phi_m.$$

similarly $E_2 = 4.44 f N_2 \phi_m$

6(b) (i) primary resistance referred to secondary, $R_1' = K^2 R_1$

$$\boxed{K = \frac{220}{2200} = \frac{1}{10}}$$

$$R_1' = \left(\frac{1}{10}\right)^2 (2.4)$$

$$= 0.024\ \Omega$$

Leakage reactance referred to secondary, $X_1' = K^2 X_1$

$$X_1' = \left(\frac{1}{10}\right)^2 \cdot 6 \Rightarrow 0.06\ \Omega$$

(ii) Equivalent resistance referred to secondary, $R_{o2} = R_2 + R_1'$

$$R_{o2} = 0.03 + 0.024 = 0.054\ \Omega$$

Equivalent reactance referred to secondary,

$$X_{o2} = X_2 + X_1' = 0.07 + 0.06$$

$$= 0.13\ \Omega$$

7(a) Discuss the effect of variation of frequency and supply voltage on losses.

Ans:- Variations in voltage and frequency effects the iron losses (hysteresis and eddy current losses

- Hysteresis loss, $P_h = K_h f B_m^{1.6}$

$$= K_h V^{1.6} f^{-0.6}$$

$\boxed{\text{as } V \propto f B_m}$

$\boxed{B_m \propto \frac{V}{f}}$

- Eddy current loss, $P_e = K_e f^2 B_m^2$

$$= K_e V^2$$

- P_h depends upon V & f, P_e on voltage V
- If V & f changed in same proportion, the flux density B_m will remain unchanged and hence iron loss remain same
- If T/F operated at frequency less than rated with correspondingly reduced voltage, iron losses be reduced.
- with increased voltage & frequency, iron losses increases.

7(b)

Rating = 25 KVA, E_1 = 2200V, E_2 = 200V, f = 50Hz

Equivalent resistance = 0.012 pu
Equivalent impedance = 0.05 pu.

⇒ output at UPf = 25 KW
maximum η = 80%.

∴ Input power = $\frac{25}{0.8}$ = 31.25 kw

∴ Full load losses = 31.25 − 25 = 6.25 kw

At max η, copper loss = iron loss

∴ Iron loss = $\frac{6.25}{2}$ = 3.125 kw

%R = 0.012×100 = 1.2%, %Z = 0.05×100 = 5%

$\%X = \sqrt{5^2 - 1.2^2} = 4.854\%$

% Regulation at half load & 0.8 Pf $= \frac{1}{2}[V_r \cos\phi + V_x \sin\phi]$

$= \frac{1}{2}[(1.2)(0.8) + (4.854)(0.6)]$

$= 1.93\%$

η at half load @ 0.8 Pf $= \left[\dfrac{x\,\text{KVA}\cos\phi}{x\,\text{KVA}\cos\phi + P_i + x^2 P_c}\right]100$

$= \left[\dfrac{\frac{1}{2}(25\times10^3)(0.8)}{\frac{1}{2}(25\times10^3)(0.8) + 3.125\times10^3 + (\frac{1}{2})^2(3.125\times10^3)}\right]100$

$= 71.9\%$.

UNIT-IV

8(a) Rating = 15 KVA, 2300/230V, 50Hz.

$I_0 = 0.21A$, $P_0 = 50W$, $V_1 = 2,300V$.

No load Pf, $\cos\phi_0 = \dfrac{P_0}{V_1 I_0} = 0.1035$

Active component of no load current, $I_w = I_0\cos\phi_0 = 0.022A$

Magnetising " " " , $I_m = I_0\sin\phi_0 = 0.209A$

$R_0 = \dfrac{V_1}{I_w} = \dfrac{2,300}{0.022} = 104545\,\Omega$ (or) $104.5k\Omega$

$X_0 = \dfrac{V_1}{I_m} = \dfrac{2,300}{0.209} = 11004\,\Omega$ (or) $11\,k\Omega$

$I_{sc} = 6A$, $V_{sc} = 47V$, $P_{sc} = 160\,W$

(i) Equivalent impedance reffered to H.V (or) primary $\Rightarrow Z_{01} = \dfrac{V_{sc}}{I_{sc}} = \dfrac{47}{6} = 7.83\,\Omega$

Equivalent resistance reffered to HV $\Rightarrow R_{01} = \dfrac{P_{sc}}{I_{sc}^2} = \dfrac{160}{6^2} = 4.442$

Equivalent reactance " " " $\Rightarrow X_{01} = \sqrt{Z_{01}^2 - R_{01}^2} = 6.45\,\Omega$

(ii) Voltage regulation $= \left[\dfrac{I_1 R_{01}\cos\phi + I_1 X_{01}\sin\phi}{V_1}\right]100$

$= \left[\dfrac{(6.52)(4.442)(0.8) + (6.52)(6.45)(0.6)}{2300}\right]100$

$= 2.1\%$.

(iii) η at half load @ UPf $= \dfrac{o/p}{o/p + \text{losses}}$

$= \dfrac{x\,\text{VA}\cos\phi}{x\,\text{VA}\cos\phi + P_i + x^2 P_c} \Rightarrow \dfrac{7,500}{7,500 + 50 + (\frac{1}{2})^2 180} = 98.7\%$

output at ½ load @ UPf $= \frac{1}{2}\times 15000 \times 1 \Rightarrow 7,500\,W$

Full load copper loss $\Rightarrow P_c = \left[\dfrac{I_{fl}}{I_{sc}}\right]^2 \cdot P_{sc} = \left[\dfrac{(15000/2300)}{6}\right]^2 160 = 180W$

8(b) Explain the conditions in detail that must be fulfilled for the satisfactory parallel operation of two single phase transformers.

Ans- (1) Rated primary voltages must be the same.

(2) The transformation ratio must be equal.

(3) The transformers should be connected with regard to polarity.

(4) The percentage impedance of the T/F are the same.

(5) The T/FS must have the same voltage regulation.

9(a) Discuss the separation of core losses in 1ϕ T/F.

Ans:→ The T/F core losses are hysteresis loss P_h & eddy current loss P_e.

→ For a given B_m; $P_h \propto f \Rightarrow P_h = af$

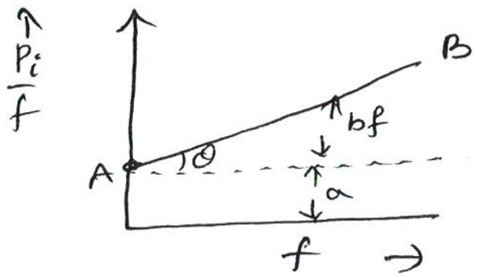
$P_e \propto f^2 \Rightarrow P_e = bf^2$

where a & b are constants.

$$P_i = af + bf^2$$

(or) $$\frac{P_i}{f} = a + bf$$

- The value of a & b can be determined by performing o.c test.
- During this test, applied voltage & frequency f are varied together, so as to keep $\frac{V}{f}$ constant.
- The core loss is obtained at different frequencies and a graph of (P_i/f) versus frequency f is plotted.
- This graph is a straight line AB of the form $y = mx + c$



- The intercept of the straight line on the vertical axis gives 'a' and the slope of the line AB gives 'b'.
- Thus, knowing the constants a and b, Hysteresis and eddy current losses can be separated.

9(b.) Rating = 200 KVA, $W_1 = 4$ kW, $W_2 = 6$ kW

Iron loss of each T/F, $P_i = \frac{W_1}{2} = \frac{4}{2} = 2$ kW

Full load cu loss of each T/F, $P_c = \frac{W_2}{2} = \frac{6}{2} = 3$ kW

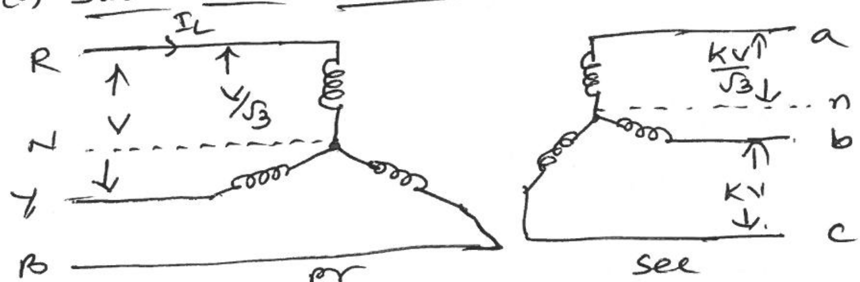
$$\eta = \frac{x\,VA\cos\phi}{x\,VA\cos\phi + P_i + x^2 P_c} = \frac{(1)(200\times10^3)(1)}{(1)(200\times10^3)(1) + 2\times10^3 + (1)^2(3\times10^3)}$$

$= 97.56\%$

UNIT-V

(10) Describe four possible ways of connections of 3ϕ T/F's with relevant relations between voltage and current on h.v and l.v sides.

Ans: (i) Star-star connection:



- Let h.v being primary and l.v being secondary

Line voltage on pr side = V

pr phase voltage = $V/\sqrt{3}$

∴ sec phase voltage = $KV/\sqrt{3}$

K - Transformation ratio

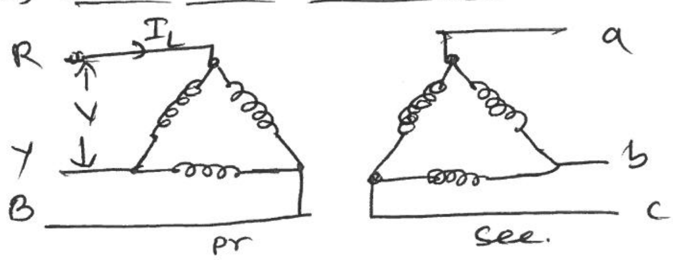
sec line voltage $= \sqrt{3}\cdot \frac{KV}{\sqrt{3}} \Rightarrow KV$

Phase current on pr side = I_L

$\boxed{I_{ph} = I_L}$

Secondary phase current = $\frac{I_L}{K}$

(ii) Delta-Delta connection:



pr side line voltage = V

$\boxed{V_{ph} = V_L}$

sec side line voltage = KV

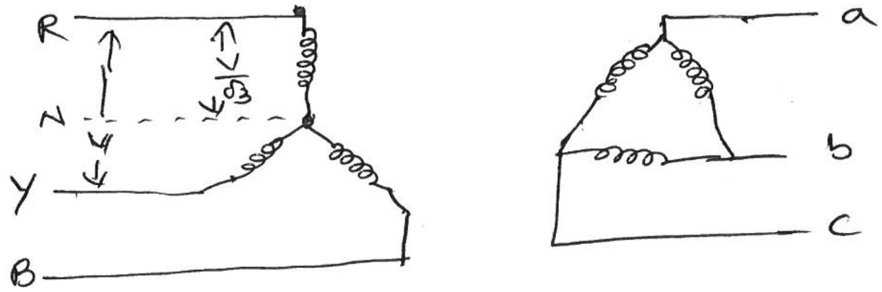
pr line current = I_L

pr phase current = $I_L/\sqrt{3}$

secondary phase current = $\frac{I_L}{\sqrt{3}K}$

Secondary line current = $\frac{I_L}{K}$

(iii) Star - Delta connection:



primary line voltage = V

primary ph voltage = $V/\sqrt{3}$

secondary ph voltage = $\frac{KV}{\sqrt{3}}$

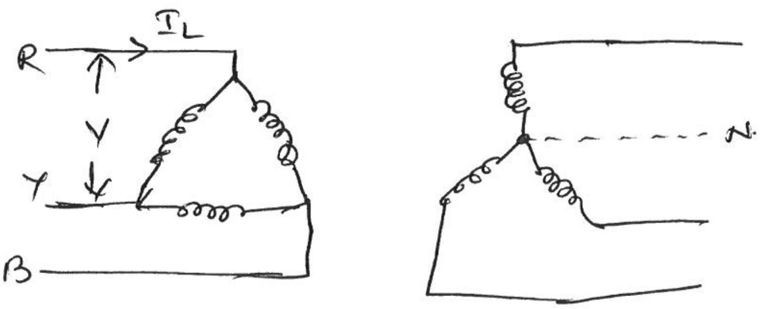
secondary line voltage = $KV/\sqrt{3}$

primary phase current = I_L

secondary phase current = $\frac{I_L}{K}$

secondary line current = $\sqrt{3}\frac{I_L}{K}$

(iv) Delta - Star connection:



pr side line voltage = V

pr side line current = I_L, pr side ph current = $\frac{I_L}{\sqrt{3}}$

secondary side phase voltage = KV

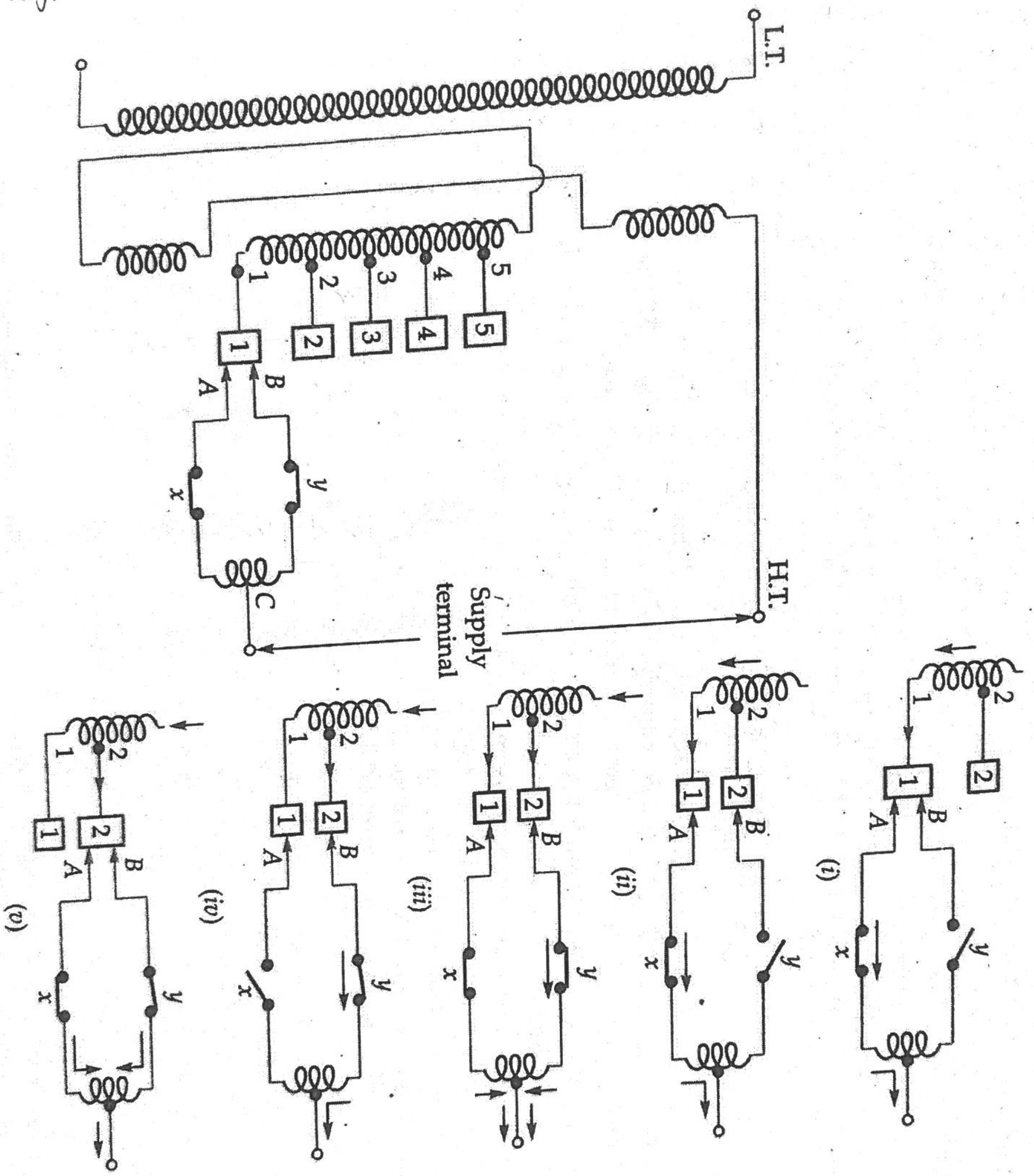
secondary side line voltage = $\sqrt{3}KV$

secondary side ph current = $\frac{I_L}{\sqrt{3}K}$

secondary side line current = $\frac{I_L}{\sqrt{3}K}$.

11 (a) Explain the operation of on load tap changing transformer.

Ans:-



(a) On-load tap-changer

(b) Sequence of operations from tapping 1 to tapping 2

- when a change in voltage is required in onload tap changing T/F, the fingers A and B can be brought to segment 2, by the following sequence of operations:

(i) open switch Y, the entire current must flow through the lower half of the reactor.

(ii) The finger B carries no current and can be moved to segment 2.

(iii) Close switch Y, the T/F winding between taps 1 & 2 gets connected across the reactor.
The reactor prevents the tapped winding from getting short circuited.

(iv) open switch x, the entire current starts flowing through the upper half of the reactor.

(v) Move the finger A from segment 1 to segment 2 and then close switch x.
The winding between taps 1 & 2 is completely out of circuit.

- If further change in voltage is required, above sequence of operation is repeated.

11(b) Discuss the parallel operation of three phase T/F's.

- All the conditions for the successful parallel operation of 1ϕ Transformers also apply to the parallel running of 3ϕ T/F

⇒ (1) Rated primary voltages must be the same.
(2) Transformation ratio must be equal
(3) The transformers should be connected with regard to polarity
(4) The percentage impedance of the T/F are the same.

⇒ Additional conditions.
(i) The secondaries of all transformers must have same phase sequence
(ii) The phase displacement between primary and secondary line voltages must be the same.