CMR INSTITUTE OF TECHNOLOGY

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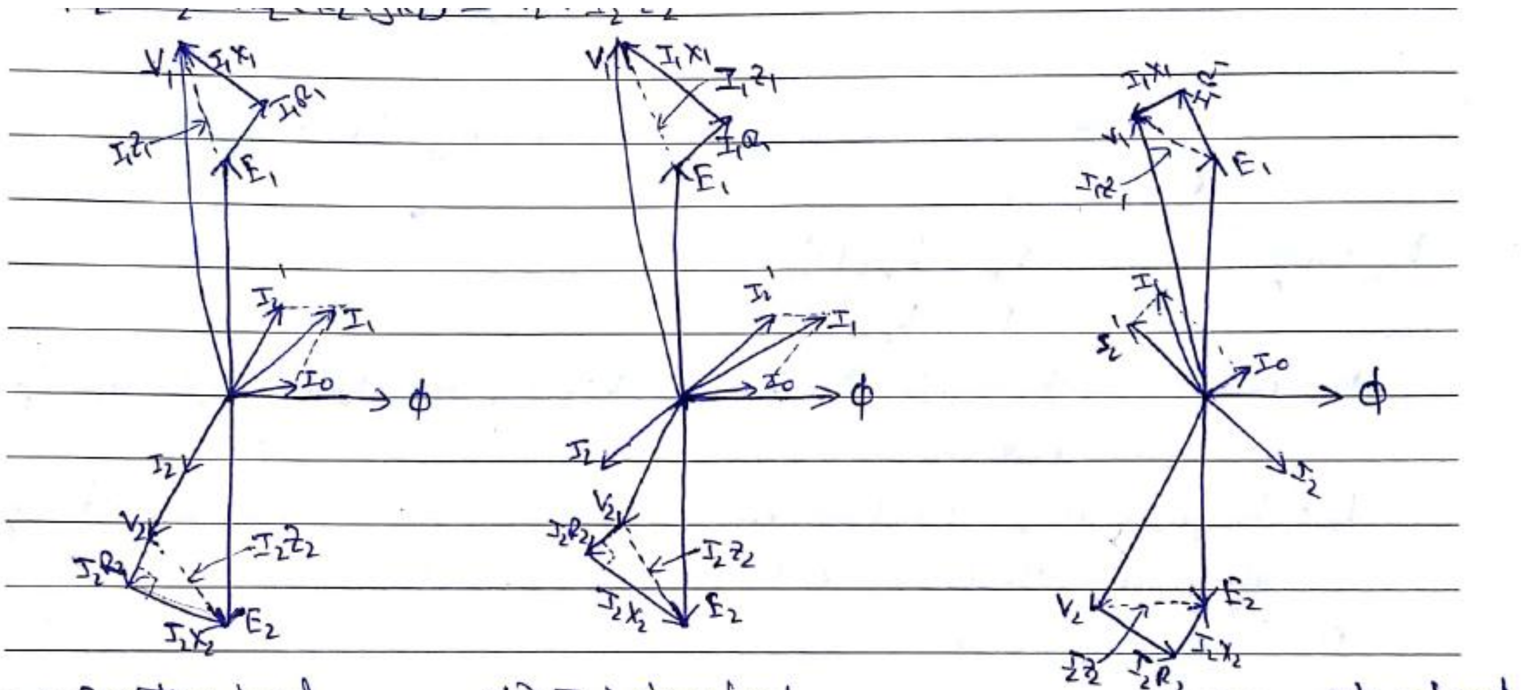
Internal Assesment Test - I

Sub:	Transformers and Generators							Code:	15EE33
Date:	21/09/2017	Duration:	90 mins	Max Marks:	50	Sem:	3rd	Branch:	EEE
Answer Any FIVE FULL Questions									

		Marks	OBE	
			CO	RBT
1 (a)	Draw the phasor diagrams of single phase transformer for lagging, leading and unity power factor loads.	[07]	C303.1	L3



(a) Resistive load. (b) Inductive load (c) Capacitive load.

(b)	What is an ideal transformer? Mention its features.	[03]	C303.1	L2

1. Its primary & secondary winding resistances are negligible
2. The core has infinite permeability (μ) so that negligible mmf is required to establish the flux in core
3. Its leakage flux & leakage inductance are zero. The entire flux is confined to the core and links both windings
4. There are no losses due to resistance, hysteresis and eddy currents. Thus, the efficiency is 100 per cent.

2 (a) Find the all day efficiency of a single phase transformer having maximum efficiency of 98% at 15KVA at UPF load and loaded as follows. 12 hours—2kW at 0.5 pf loading 6 hours—2kW at 0.8 pf lagging 6 hours—No load.	[10]	C303.3	L3

Solution: For maximum efficiency

$$\text{Output} = 15 \times 1.0 = 15 \text{ kw}$$

$$\text{Input} = \frac{\text{Output}}{\eta} = \frac{15}{0.98} = 15.306 \text{ kw}$$

$$\text{Total losses} = \text{Input} - \text{output} = 15.306 - 15 = 0.306 \text{ kw}$$

$$\text{Full load copper loss, } P_c = \text{Iron loss} = \frac{\text{Total losses}}{2} = \frac{0.306}{2} = 0.153 \text{ kw}$$

Since for maximum efficiency, $P_i = P_c$

$$\text{All-day output} = (2 \times 12) + (12 \times 6) = 96 \text{ kwh}$$

$$\text{Iron loss for 24-hours} = 0.153 \times 24 = 3.672 \text{ kwh}$$

$$\text{Copper loss for 24-hour} = \left(\frac{2/0.5}{15}\right)^2 \times 0.153 \times 12 + \left(\frac{12/0.8}{15}\right)^2 \times 0.153 \times 6 = 1.04856 \text{ kwh}$$

$$\text{All-day efficiency, } \eta = \frac{\text{Output}}{\text{Output} + \text{total losses}} \times 100 = \frac{96}{96 + 3.672 + 1.04856} \times 100 = 95.31\ \%\ \textbf{Ans.}$$

3 (a) A 4-KVA, 200/400 V single phase transformer is supplying the full load current at 0.8 p.f lagging, the OC/SC test results are: OC test: 200V, 0.8A, 70W SC test: 20V, 10A, 60W (HV side) Calculate its efficiency.	[10]	C303.4	L3

Solution: Transformer output, $P = 4 \times 0.8 = 3.2$ kw or 3,200 W

$$\text{Full-load secondary current, } I_2 = \frac{4 \times 1{,}000}{400} = 10 \text{ A}$$

Full-load copper loss, $P_c = P_s = 60$ W since short-circuit current $I_s = I_2 = 10$ A

Iron loss, $P_i = 70$ W

$$\text{Full-load efficiency, } \eta = \frac{P}{P + P_i + P_c} \times 100 = \frac{3{,}200}{3{,}200 + 70 + 60} \times 100 = 96.1\ \%\ \textbf{Ans.}$$

4 (a) State the advantages of using a bank of three single-phase transformers over single three-phase transformer.	[05]	C303.3	L4

Advantages of 3-ϕ unit T/f:-

(i) It takes less space

(ii) It's lighter, smaller & cheaper as the volume of core required is less

(iii) It is slightly more efficient

(iv) The costly high voltage terminals to be brought out of the transformer housing are reduced to three rather than six in 3-separate 1-ϕ T/fs.

(b) List out the conditions for satisfactory parallel operation of (i) single phase transformers (ii) Three phase transformers. [05] C303.4 L2

Conditions to satisfy:-

(i) The polarities of T/fs must be same

(ii) Identical primary & secondary voltage ratings

(iii) Impedances inversely proportional to KVA ratings.

(iv) Identical X/R ratios in T/f impedances.

are conditions in case of 1-ϕ T/f. in addition

(a) Phase sequence must be same

(b) phase shift b/w Pri & sec voltages must be same for all T/fs which are to be paralleled. ie all transformers in same main group can be connected in parallel.

5 (a) A three phase step down transformer is connected to 6.6kv mains and takes 10A. calculate the secondary line voltage, line current and output for the following connections: [10] C303.4 L3

(i) Δ / Δ (ii) Δ/ Y

The turns ratio is 12. Neglect losses.

Solution : Primary line voltage, V_{L1} = 6.6 kv = 6,600 V

Primary line current, I_{L1} = 10 A

$$\text{Turn-ratio} = \frac{N_1}{N_2} = 12$$

(i) Δ–Δ Connections

Primary phase voltage, $V_{P1} = V_{L1} = 6{,}600$ V ∵ winding is delta-connected

$$\text{Secondary line voltage, } V_{L2} = V_{P2} = V_{P1} \times \frac{N_2}{N_1} = \frac{6{,}600}{12} = 550 \text{ V Ans.}$$

$$\text{Primary phase current, } I_{P1} = \frac{I_{L1}}{\sqrt{3}} = \frac{10}{\sqrt{3}} = 5.773 \text{ A}$$

$$\text{Secondary line current, } I_{L2} = \sqrt{3}\, I_{P2} = \sqrt{3} \times I_{P1} \times \frac{N_1}{N_2} = \sqrt{3} \times 5.773 \times 12 = 120 \text{ A Ans.}$$

Δ/Y Connections

Primary phase voltage, $V_{P1} = V_{L1} = 6{,}600$ V

$$\text{Secondary line voltage, } V_{L2} = \sqrt{3}\, V_{P2} = \sqrt{3} \times V_{P1} \times \frac{N_1}{N_2} = \sqrt{3} \times \frac{6{,}600}{12} = 952.6 \text{ V Ans.}$$

$$\text{Primary phase current, } I_{P1} = \frac{I_{L1}}{\sqrt{3}} = \frac{10}{\sqrt{3}} \text{ A}$$

$$\text{Secondary line current, } I_{L2} = I_{P2} = I_{P1} \times \frac{N_1}{N_2} = \frac{10}{\sqrt{3}} \times 12 = 69.28 \text{ A Ans.}$$

6(a) Two 100 V, 1-Φ furnaces supply loads of 600 kW and 900 kW respectively at a power factor of 0.707 lagging and are supplied from 6600V ,3-phase supply through a Scott connected transformer. Calculate the line currents in the 3-phase side. Also draw the phasor diagrams.	[10]	C303.5	L3

SOLUTION. $a = \frac{660}{100} = 66$

For main transformer

$$P_{2m} = V_{2m} I_{2m} \cos \phi_{2m}$$

$$I_{2m} = \frac{P_{2m}}{V_{2m} \cos \phi_{2m}} = \frac{900 \times 10^3}{100 \times 0.707} = 12730 \text{ A}$$

For teaser transformer

$$I_{2t} = \frac{P_{2t}}{V_{2t} \cos \phi_{2t}} = \frac{600 \times 10^3}{100 \times 0.707} = 8486 \text{ A}$$

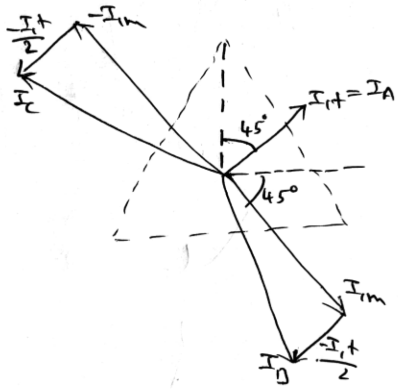
$$I_{1t} = \frac{2}{\sqrt{3}}\frac{I_{2t}}{a} = \frac{2}{\sqrt{3}} \times \frac{8486}{66} = 148.5 \text{ A}$$

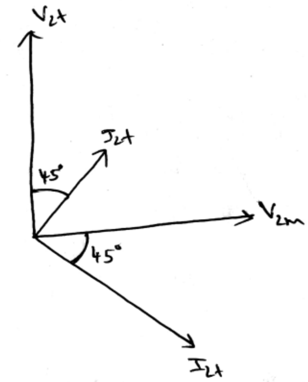
$$I_{1m} = \frac{I_{2m}}{a} = \frac{12730}{66} = 192.9 \text{ A}$$

$$I_A = I_{1t} = 148.5 \text{ A}$$

$$I_B = I_C = \sqrt{I_{1m}^2 + \left(\frac{1}{2}I_{1t}\right)^2}$$

$$= \sqrt{(192.9)^2 + \left(\frac{148.5}{2}\right)^2} = 206.7 \text{ A}$$





7(a)	Two single phase transformers, rated at 250KVA each are operated in parallel on both sides. Impedances of transformers with respect to secondary are (1+j6)Ω and (1.2+i4.8)Ω respectively. Find the load shared by each transformer, when the load is 500kVA at 0.8 pf lagging.	[10]	C303.5	L3

Sol:-

$S_{rA} = S_{rB} = 250$ kVA

$Z_A = 1 + j6\ \Omega$

$Z_B = 1.2 + j4.8\ \Omega$

$Z_A + Z_B = 2.2 + j10.8\ \Omega$

$S_L = 500$ kVA, 0.8 pf lag. = total load

load shared by T/f A $= S_A = S_L \frac{Z_B}{Z_A + Z_B} = 22.445\angle{-39.38°}$ kVA

$= 22.445$ kVA at 0.773 lag.

load shared by T/f B $= S_B = S_L \frac{Z_A}{Z_A + Z_B} = 27.59\angle{-34.8°}$ kVA

$= 27.59$ kVA at 0.8211 lag.