Diploma in Engineering Summer – 2015 Examinations

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

1 **Attempt any *TEN* of the following:** 20

1 a) State Fleming's right hand rule.

1 a) **Ans:**

FLEMING'S RIGHT HAND RULE :-

Stretch the first three fingers of your right hand such that they are perpendicular to each other ,***if*** first finger indicates direction of magnetic field, thumb indicates direction of force ***then*** the middle finger will indicate the of EMF / current. 2 Marks

1 b) Write e.m.f. equation of generator.

1 b) Ans:

EMF equation of Generator

$$E_g = \frac{PZ\Phi N}{60A} \text{ Volts}$$

1 Mark

Where,
E_g = generated emf in volts
P= number of poles
Z= total number of conductors
Ø= flux in wb
A= number of parallel paths
N= speed of rotation

1 Mark

1 c) State significance of back emf.

1 c) **SIGNIFICANCE OF BACK EMF IN D.C. MOTOR:-**

- As the armature of the DC motor starts rotating, the flux which is responsible for their rotation is cut and consequently an e.m.f. is induced in them in accordance with Faraday's law of electromagnetic induction.
- This e.m.f. always acts in opposition with the applied voltage (V) and is known as back e.m.f. E_b or counter e.m.f.
- Since the back e.m.f. opposes the applied voltage across the armature, the net voltage acting in the armature circuit is the difference between these, this effective voltage determines the value of armature current (Ia).
- If R_a is the armature resistance, then from Ohm's law, Ia = (V-. E_b)/R_a amperes.
- In the running condition, . E_b is nearly equal to V. As the internal resistance of the armature of a d.c. motor being very low, it is the back e.m.f. which mainly limits the armature current in the running condition of the motor.

2 Marks

1 d) Define armature torque . and shaft torque.

1 d) **Armature torque:** Torque developed by the armature of motor is given by –

$$T_a = \frac{Z\,P}{2\pi A}\phi I \text{ N-m}$$ 1 Mark

Where: Z = total number of armature conductors, P = number of poles of the field, A = number of parallel paths in armature, I = armature current (A), Ø = flux per pole in Webers

Shaft torque: It is the torque available at the shaft of the motor for doing useful work. It is less than armature torque due to windage, friction, stray and iron losses in the motor.

$$T_{sh} = \frac{Output}{2\pi . n} \text{ N-m}$$ 1 Mark

where the output is in Watts & '*n*' = the speed in Rounds Per Second.

1 e) 'D.C. series motor should never be started at 'no load'. Justify.

1 e) At no load the field current (which is also the armature current) is very small and hence the useful air-gap field flux. Also the torque is very small.

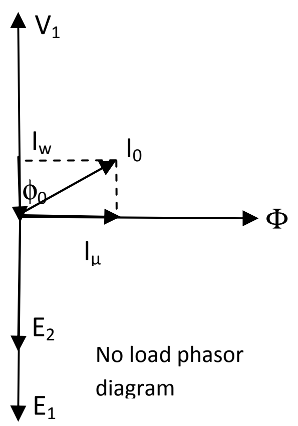
As $N \propto \frac{1}{\Phi}$, the speed rises to excessively high values mechanically very harmful for the machine. At high speeds due to centrifugal forces of the rotating parts they may damage the machine. Hence DC series motor should never be started on no load. 2 marks

1 f) State the condition for maximum efficiency of a d.c. motor.

1 f) Maximum efficiency of DC motor during its operation occurs when the **VARIABLE LOSSES** become equal to the **CONSTANT LOSSES.**
Example for the DC shunt motor:
As it is nearly constant speed operation motor the variable losses are the armature copper losses and constant losses are (field copper losses + iron losses + stray losses + friction + windage losses). 2 Marks (example not expected)

1 g) Draw the phasor diagram for practical transformer on no load.

1 g)



No load phasor diagram

2 Marks

Where,

I_0 = no load primary current , No load current current I_0 has two components,
I_μ = magnetising (wattless) component of No load current
I_w =active (working) component of no load current.

1 h) Define All day efficiency

1 h) All day efficiency: It is the ratio of output energy in kWh to the input energy in kWh in the 24 hours of the day. 2 Marks

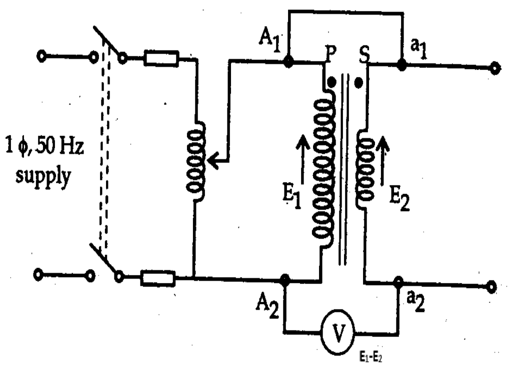
OR

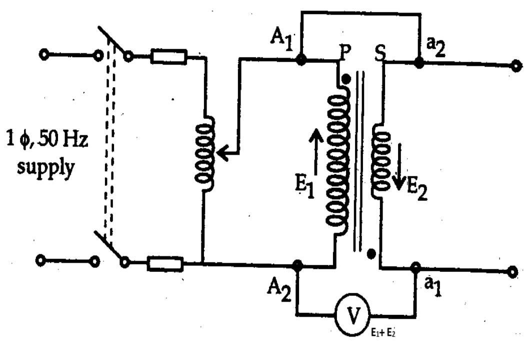
$$\text{All Day Efficiency} = \frac{\text{output energy in kWh in 24 hrs}}{\text{input energy in kWh in 24 hrs}}$$

1 i) Draw circuit diagram for polarity test on 1 Ø transformer.

1 i) Subtractive Polarity Additive Polarity

Each polarity 1 Mark = 2 marks





1 j) A 50 KVA transformer has iron loss of 2 KW on full load. Calculate its iron loss at 75% of full load.

1 j) Ans:
For nearly constant voltage operation of transformer
Iron Loss is constant at any load as it depends on voltage, 2 Marks
hence iron loss at 75% of Load = **Iron loss at full load= 2 kW**.

1 k) List the types of transformer cooling using air.

1 k) **Ans:**
Transformer cooling using air only:
i) Air Natural 1 Mark Each
ii) Air blast (or forced air)

1 l) State two advantages of 3-phase autotransformer

1 l) **Ans:**

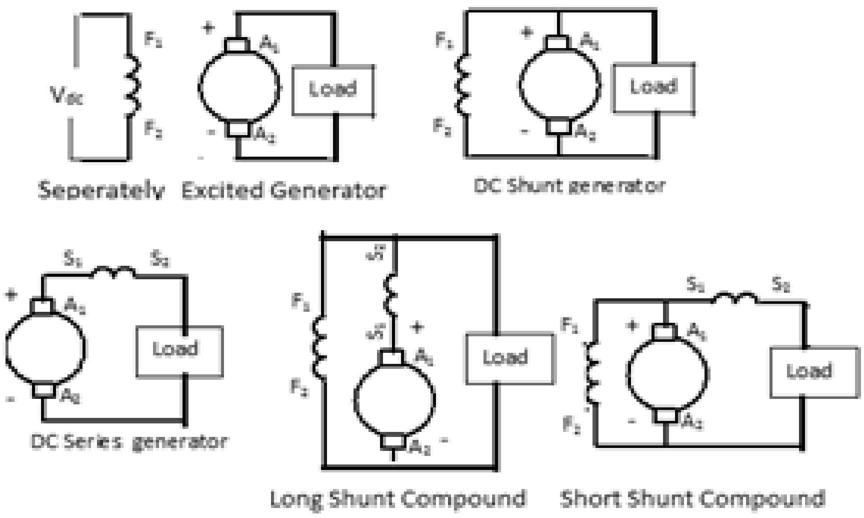
Advantages of 3 ph autotransformer compared to identical (capacity) 3 phase six winding transformer:

i) Reduction in copper required — 1Marks Each (Any Two)
ii) Cost is lower.
iii) The size is reduced, lower weight.
iv) Losses are reduced
v) Higher efficiency.
vi) Better Voltage regulation
vii) Variable output voltage.

2 Attempt any FOUR of the following: 16

2 a) Draw the connection diagrams of different types of DC Generators

2 a)



1 mark each any four = 4 marks

2 b) State function of following parts of d.c. machine.
(i) Yoke (ii) · Brush, (iii) Pole shoe, · (iv) Commutator

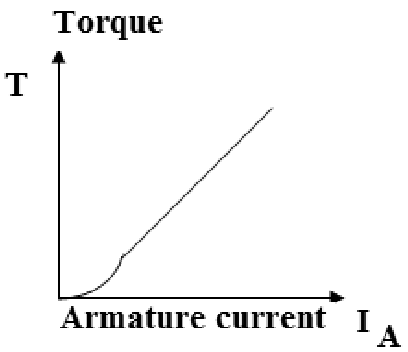
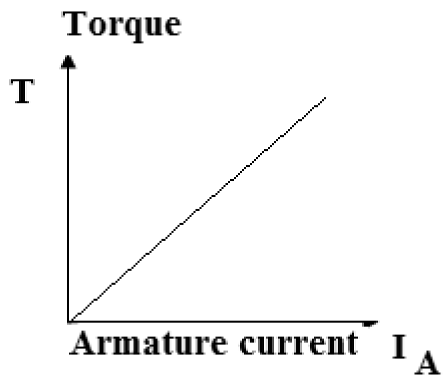
2 b) Ans:

Part	Function
Yoke	-Provides Mechanical support for Poles - Acts as Protecting cover for Machine -Carries magnetic Flux
Brush	-To Collect current for generator armature or to inject current in motor armature.
Pole Shoe	-Spread out Flux in air gap. -Support field winding.
Commutator	-Convert AC to DC for generator in Armature Or -DC to AC for motor

1 mark for any one function of each part

2 c) Describe Ta - .Ia characteristic for DC senes and DC shunt motor.

2 c) 1 Mark for Each Characteristics

DC Series Motor	DC Shunt Motor
	
$T_a \propto \phi . I_a$ Up to magnetic Saturation $\phi \propto I_a$, Therefore $T_a \propto I_a^2$ Hence the characteristic is a parabola passing through origin. Beyond saturation ϕ is constant, Therefore $T_a \propto I_a$ Hence the characteristic is straight line.	$T_a \propto \phi . I_a$ Field current is constant Flux is also constant Therefore $T_a \propto I_a$ Hence the characteristic is straight line passing through zero.

1 Mark Each for Description

2 d) A 220 V de shunt motor runs at a speed of 850 rpm and takes a current of 30 A from mains. Calculate speed if the torque is doubled. Armature resistance is 0.2 Ω.

2 d) *Solution*

$$T_{a1} = \phi \text{ x } I_{a1}$$

$$T_{a2} = \phi \text{ x } I_{a2}$$

As, $T_{a2} = 2T_{a1}$

$$\frac{T_{a2}}{T_{a1}} = \frac{\phi . I_{a2}}{\phi . I_{a1}}$$

$$\therefore \; I_{a2} = 2I_{a1}$$

$$\therefore \; I_{a2} = 2 \text{ x } 30 = \mathbf{60\ Amp.}$$

$$E_{b1} = V - I_{a1}.R = \mathbf{214\ volts}$$

Also, $E_{b2} = V - I_{a2}.R = \mathbf{208\ \ volts}$ 1 Mark

Assuming linear magnetization curve,

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}} \times \frac{\Phi_1}{\Phi_2}$$ 1 Mark

As, $\phi_1 = \phi_2$

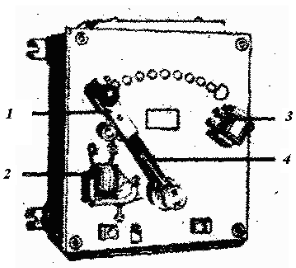
$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$$ 1 Mark

1 Mark

$\therefore$ N_2 = **826.16 RPM**

2 e) Identify parts of d.c. motor starter shown m Figure No. 1.State function of each part.

2 e) Ans: Parts of 3 point starter



½ mark for each part and

Part	Part Name	Function
1	Soft iron	-Hold Handle during motor running condition
2	Overload Coil	-Protect motor against overload
3	No Volt Coil	-Protect the motor from Low voltage/Power failure/ field Failure
4	Handle	-Provide path for current - Cutting resistance from OFF to ON position

½ Mark for function of each part

2 f) List any four applications of D.C. shunt motor.

2 f) **Ans:**

Applications of DC shunt motor-

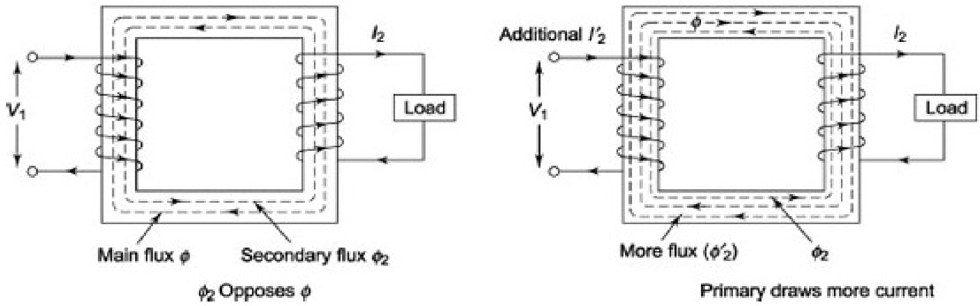
i. Lathe Machine
ii. Drilling Machine
iii. Milling Machine
iv. Printing Machine
v. Pumps
vi. Blowers
vii. Fans, (any other application related to Dc shunt motor may be considered)

1 Mark each for any four applications

3 Attempt any FOUR of the following: 16

3 a) Describe practical transformer on load with phasor diagram.

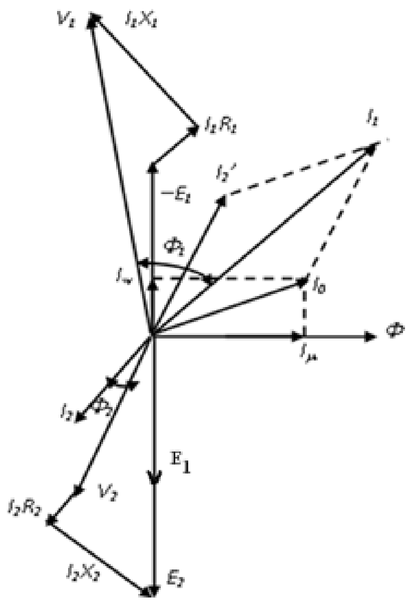
3 a)



For inductive load:

When transformer is loaded current I_2 flows through secondary
With inductive load it lags behind V_2
I_2 sets up Φ_2, opposes main flux Φ and weakens it.
E_1 reduces, more primary current flows = $I_o + I_2'$
Sets up Φ_2' which opposes Φ_2, $\Phi_2' = \Phi_2$, $I_2' = k\ I_2$
Neglecting I_o, $I_2' = I_1$

2 Mark for description



2 Mark for phasor diagram

If Phasor diagram for capacitive or resistive load is drawn & its description is given then also be considered

3 b) "All day efficiency is more than ordinary efficiency of a transformer." Justify.

3 b) Ans: Expected answer from students:

The distribution transformers are energized for 24 hours of the day wherein the constant losses occur continuously and the copper losses occur varyingly with respect to the load for different times of the day. Thus varying powers are drawn due to which the efficiency varies drastically over the whole day. Thus the performance of the transformers need to be judged in terms of the energy efficiency (or in terms of the energy it supplies) rather than the commercial efficiency. 2 Marks

The distribution transformers are designed to operate at maximum efficiency at about 60 to 70 % of the rated load. Their copper losses vary significantly. Also as the constant losses are continuous for the whole day more the no load and low load condition lower will be the efficiency. Hence the all day efficiency is always lower than the power efficiency (ordinary efficiency). 2 Mark

3 c) List the conditions for parallel operation of three phase transformer.

3 c) **Ans:**

Conditions for Parallel operation of 3 ph transformer

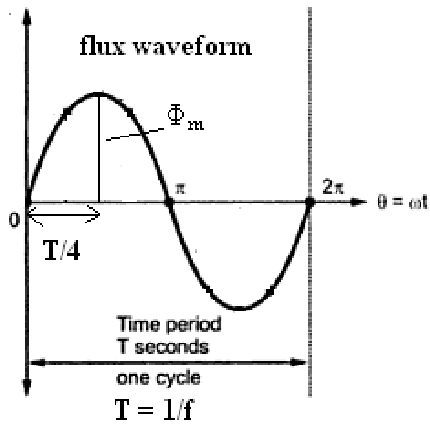
1) Voltage ratings of both the transformers must be identical. 1 Mark each
2) Percentage / p.u. impedance should be equal in magnitude. (any Four)
3) X / R ratio of the transformer winding should be equal.
4) Transformer polarity must be same.
5) Phase displacement between primary & secondary voltages must be same.
6) Phase sequence of both must be same.

3 d) Derive the emf equation of a transformer.

3 d) **Ans:**

Emf equation of transformer:

N_1 = No. of turns on primary winding
N_2 = No. of turns on secondary winding
Φ_m= maximum value of flux linking both the winding in Wb
F = Frequency of supply in Hz
1st method 1 M



T = 1/f

Maximum value of flux is reached in time t = 1/ 4f 1 M

Avg. rate of change of flux $=\Phi_m/t = \Phi_m/(1/4f) = 4\Phi_m f$ Wb/sec

From faraday's laws of electromagnetic induction

Avg. emf induced in each turn = Avg. rate of change of flux = $4\Phi_m f$

Form factor = (RMS value)/(Avg. value) = 1.11

R.M.S. emf induced in each turn = 1.11 x Avg. value = 1.11 x $4\Phi_m f$

= 4.44 Φm f volts 1 M

R.M.S. emf induced in primary winding = (RMS emf / turn) x N_1

$E_1 = 4.44\ \Phi_m f\ N_1$ volts

Similarly, $E_2 = 4.44\ \Phi_m f\ N_2$ volts 1 M

OR II^nd method **OR**

$\Phi = \Phi_m \sin \omega t$ 1 M

According to Faraday's laws of electromagnetic induction

Instantaneous value of emf/ turn = $-d\Phi/dt = -d/dt\,(\Phi_m \sin \omega t)$

$= -\omega\Phi_m \cos \omega t$

$= \omega\Phi_m \sin(\omega t - \pi/2)$ volts 1 M

Maximum value of emf/turn= $\omega\Phi_m$

But $\omega = 2\pi f$

Max. value of emf /turn $=2\pi f\ \Phi_m$

RMS value of emf /turn = 0.707 x $2\pi f\ \Phi_m$

$= 4.44\Phi_m f$ volts 1 M

RMS value of emf in primary winding $E_1 = 4.44\Phi m\ f \times N_1$ volts and

$E_2 = 4.44\ \Phi m f\ N_2$ volt 1 M

3 e) List the advantages of O.C. and S.C. test. (any four)

3 e) **Advantages of OC & SC test** 1 Mark Each

i) Efficiency can be found for any desired load without actual loading.
ii) Power consuption is less as compared to direct loading
iii) Losses can be found at any load condition
iv) Using these tests efficiency and voltage regulation at any load condition and power factor will be calculated

3 f) A 500 KVA, distribution transformer having copper and iron losses of 5 KW and 3 KW respectively on full load. The transformer is loaded as shown below,

Loading (KW)	Power factor (lag)	No. of hrs.
400	0.8	06
300	0.75	12
200	0.8	4
No load	-	2

Calculate all day efficiency.

3 f) Ans: (table format not compulsory)

Load in kW	Pf	Hrs	Energy= P * t in kWh	Load kVA = kW / pf	X= (load kVA / rated kVA)	Copper loss = x^2* FL cu loss * Hrs in kWh	Iron loss for 24 Hrs in kWh
400	0.8	6	2400	500	1	30	3 x 24 = 72
300	0.75	12	3600	400	0.8	38.4	
200	0.8	4	800	250	0.5	5	
No load	-	2	-	-	-	-	
			6800			**73.4**	**72**

Total energy 1 Mark

Cu energy loss 1 Mark

Iron energy loss 1 Mark

Total energy loss = 73.4 + 72 = 145.4 kWh

All day efficiency = 6800 / (6800 + 145.4) = **97.90** % Efficiency 1 Mark

4 Attempt any FOUR of the following: 16

4 a The efficiency of a 100 KVA, 11000/.440 V, 1 Ø transformer is 87% on half load at 0.8 (lag) and 89% on full load at unity p.f. Determine iron and copper losses.

4 a) Ans:

$$\eta = \frac{(x)KVA(\cos\Phi)}{(x)KVA(\cos\Phi) + P_i + x^2 P_C}$$ 1 Mark

At half load 0.8 pf lag,

$$0.87 = \frac{(0.5).100(0.8)}{(0.5).100(0.8) + P_i + 0.5^2 P_C}$$

$$0.87 = \frac{40}{40 + P_i + 0.5^2 P_C}$$ 1 Mark

$P_i + 0.25P_c = 5.977$ ……………(1)

At full load upf,

$$0.89 = \frac{(1).100(1)}{(1).100(1) + P_i + 1^2 P_C}$$

$$0.89 = \frac{100}{100 + P_i + P_C}$$

$P_i + P_c = 12.35$ ……………(2)

By solving Equation (1) and (2)

| P_i=3.85 kW | Full load P_c=8.5 kW |

P_i _ 1 Mark
Pc _ 1 Mark

4 b) Identify the circuit difigram given in Figure 2. Select proper range of all meters if the transformer is having rating of 220/110 V, 1 KVA.

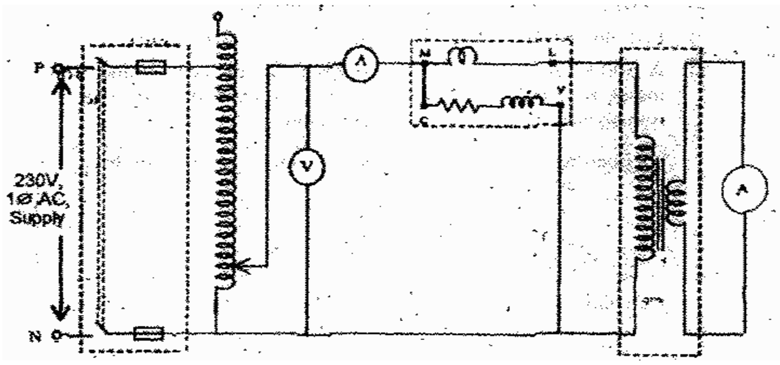


figure 2

4 b) Ans:

Given circuit is for short circuit test on single phase transformer: — 1 mark for identification

Primary full load current = (1000/220) = 4.54 A.

Secondary full load current = (1000/110) = 9.09 A.

Normally the impedance voltage does not exceed 8 % or 10 % of the rated voltage (which is 10 % of 220 V = 22 V)

Rating of meters on primary side

Ammeter-	0 - 5 Amp	½ Mark
Voltmeter-	0 -30 Volts	½ Mark
Wattmeter	5 Amp /(50/60/75) Volts	1 Mark

Rating of meters on secondary side

Ammeter	0 - 10 Amp	1Mark

4 c) Two single phase transformers of 250 KVA each are operated on parallel (both side). Their % drops are (1 + j6) ohm and (1.2 + j4.8) ohm. The load connected across the bus bar is 500 KVA at 0.8 p.f. lag. Calculate load shared by each transformer.

4 c) Ans:

As given machines are having equal kVA ratings we may assume the given impedances to be in % or Ohmic values (any one)

Given- $Z_A = 1 + j6 = 6.08\angle 80.53\ \Omega$, $Z_B = 1.2 + j4.8 = 4.94\angle 75.96\ \Omega$ — 1 Mark

$Z_A + Z_B = 2.2 + j\,10.8 = 11.02\angle 78.48^o\ \Omega$. — 1Mark

We know that,

$S_A = S * Z_B/(Z_A+Z_B)$ — 1 Mark

$= 224.45\angle -39.4°$ kVA

$S_B = S * Z_A/(Z_A+Z_B) = 275.86\angle -34.82°$ kVA — 1 Mark

4 d) State advantages of parallel operation of transformers.

4 d) **Ans:**

Advantages of parallel operation of transformers: — 1 mark for each

i) Reliability of the supply system enhances.

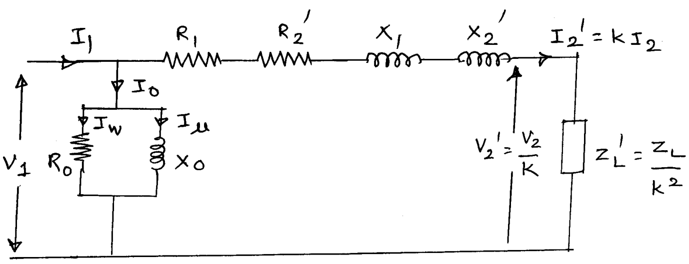
ii) Highly varying load demands can be fulfilled.

iii) loading only the relevant capacity transformer to operate at high efficiency.

iv) Overloading of transformers is avoided and hence of life of transformer increases.
(Any related advantages should be considered)

4 e) Draw the equivalent circuit of a typical 1 Ø transformer referred to primary.

4 e) Approximate equivalent circuit referred to Primary:



Labeled Diagram 2 Marks, partial diagram 1 mark

$R_o = V_1 / I_w$ and $X_o = V_1 / I_\mu$

$K = E_2 / E_1 = N_2 / N_1 = V_2 / V_1$

$V_2' = V_2 / K$

$I_2' = K I_2$

$R_2' = R_2 / K^2$ and $X_2' = X_2 / K^2$

$R_{01} = R_1 + R_2' = R_1 + R_2 / K^2$ R_{01} _ 1 mark

$X_{01} = X_1 + X_2' = X_1 + X_2 / K^2$ X_{01} _1 mark

4 f) Identify the parts shown ·in the diagram of a transformer in Figure No. 3.

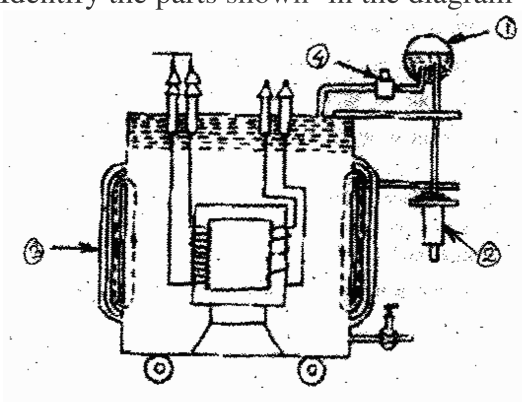


figure 3

4 f **Ans:**
Parts of Transformer
1- Conservator Tank
2- Breather
3- Cooling tubes
4- Buchholz's Relay

1 Mark for Each

5 **Attempt any FOUR of the following:** 16

5 a) List various losses in a transformer. State methods to minimize these losses.

5 a) **Ans:**

Losses in the transformer:

½ Mark for each Loss

½ Mark for Method to minimize loss.

Sr. No.	Losses	Methods to minimize Losses
1	Primary winding copper losses and secondary winding copper losses	By selecting low resistance conductor for windings.
2	Eddy current losses in core.	By using thin sheets (laminations) of electromagnetic core material insulated from each other for the core.
3	Hysteresis loss in core.	By using thin high grade silicon steel laminations insulated from each other for the core.
4	Stray Losses	It can be achieved by the spliting of conductors in to small strips to reduce Eddy currents in the conductors.

5 b) "O.C. test is performed on HV winding and S.C. test is performed on LV winding of a transformer". Justify.

5 b) Ans:

OC test is conducted to determine mainly the iron losses at rated voltage.

Open circuit test is conducted on L.V. side (H. V. open), to overcome the following difficulties:

i) Meters of required high range will be needed when it can be conducted using low range meter at low voltage without loss of accuracy. 2 Marks

ii) For testing, high voltage supply may not be available.

iii) Working with H. V. is unsafe.

Hence O.C. test is conducted by keeping H. V. open circuited.

SC test is conducted to determine the copper losses at the rated current or the required load current.

S. C. test is carried on H. V. side (L. V. short circuited), to overcome the following difficulties: 2 Marks

i) As full load current of L. V. Side is very large, Autotransformer capable of handling this current may not be readily available to supply the current.

ii) High range current meters required will be needed when it can conducted using low range ammeters on HV side (as HV supply side voltage required is low) (LV shorted).

iii) Working with higher current is unsafe.

Hence S.C. test is conducted by keeping L. V. short circuited.

5 c) Two transformers are having voltage regulation of 3% and 5% respectively. Which transformer is better in performance? Justify your answer.

5 c) Ans:

The performance of transformer having Voltage regulation equal to **3% is better** than the transformer with voltage regulation 5% as it has lower voltage variation with respect to load current variation. 1 Mark

Justification- 1 Mark

$$\%\text{ Voltage regulation} = [(V_{NL}-V_L) / V_{NL}] \times 100.$$

As no load voltage is constant, % voltage regulation depends on load voltage. For better performance of the transformer load voltage must be nearly same as no load voltage. In above case, the load voltage is higher when voltage regulation is 3%. (i.e. V_L for 3% > V_L for 5%) 2 Mark

5 d) State criteria for selection of distribution transformer.

5 d) **Selection Criteria for distribution transformer:**

i) Ratings **-** The kVA ratings should comply with IS : 2026 (Part l)-1977*. The no-load secondary voltage should be 433 volts for transformers to be used in 415 V system. Voltage should be normally in accordance with IS: 585-19627 except for special reasons when other values may be used.

ii) Taps -The transformers of these ratings are normally provided with off-circuit taps on HV side except in special cases when on-load tap, changers are specified. The standard range for off-circuit taps which are provided on HV side should be f 2'5 percent and f 5.0 percent. In case of on-load tap changers, the taps may be in steps of 1.25 percent with 16 steps. The positive and negative taps shall be specified to suit the system conditions in which the transformer is to be operated.

iii) Connection Symbol - The two winding transformers should be preferably connected in delta/star in accordance with IS : 2026 (Part 4)-1977s. The exact connection symbol (Dyn 11 or Dyn 1) is to be specified depending upon requirements of parallel operation. 1 Marks Each (any four criteria)

iv)Impedance - Consideration shall be given in the selection of impedance for the standard available rating of the switchgear on the secondary side and associated voltage drops

v) Termination Arrangement - The HV and LV terminals may be bare outdoor bushings, cable boxes or bus trunking depending upon the method of installation. Wherever compound filled cable boxes are used, it is preferable to specify disconnecting chamber between transformer terminals and cable box to facilitate disconnection of transformer terminals without disturbing the cable connections (see also IS : 9147-1979:). In case of extruded insulation cables with connections in air, a separate disconnecting chamber is not necessary.

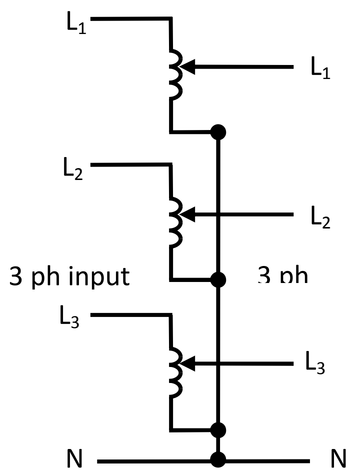
vi) Cooling - The transformers covered in this group are generally ONAN, AN

OR

i) Tariff applicable to consumers covered.
ii) Standard sizes available to cover the loads specified.
iii) Easy availability of spares when needed.
iv) Distribution transformer must be such that it is loaded around 70 to 80 % of its rating.
v) Types of loads to be supplied (as motor loads, furnaces, single phase domestic, etc.)

5 e) Draw the construction of three phase autotransformer. State its two applications.

5 e) Ans:



2 Marks for construction diagram

(Note: Any other equivalent constructional diagram of three phase autotransformer should be considered.)

Applications:

1 mark each application (any Two)

i) Reduced voltage motor starter for induction motor
ii) Series line voltage booster.
iii) Variac for suplying variable voltage to load.
iv) Control equipment for Electric Locomotive (Or Traction Motors)
v) For interconnection of different power systems

5 f) Compare distribution transformer and power transformer on basis of voltage level, turns ratio, type of cooling and cost.

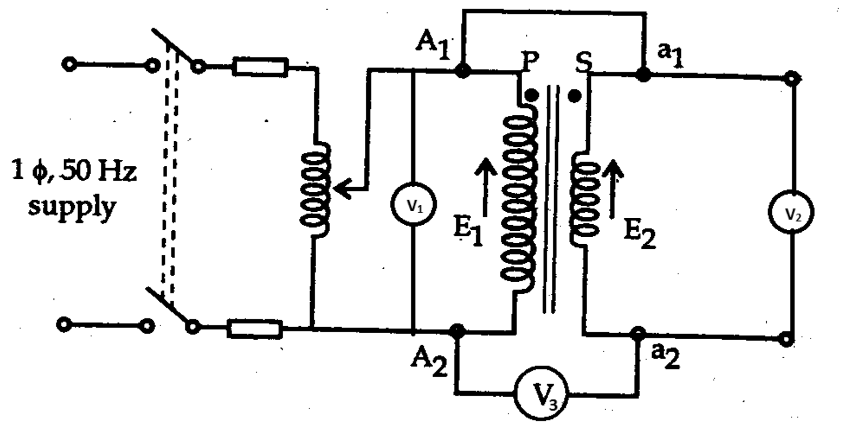
5 f) Ans:

1 Mark Each

Parameters	DISTRIBUTION TRANSFORMER	POWER TRANSFORMER
Voltage Level	11 kV or Low	33 kV or More
Turns ratio	Higher	Lower
Type of cooling	AN, ONAN	AB, ONAF, OFAF
Cost	Low	High

5 g) Describe procedure to find polarity of windings of a three phase transformer.

5 g) Ans:
Carry out the phasing out test to determine /confirm the corressponding terminals of the primary & secondary windings of each phase. Then perform the polarity test as below.



2 mark fig

The transformer is connected to a low voltage a.c. source with the connections made as shown in the ***Figure .*** A ***supply voltage V***$_1$ is applied to the primary and the readings of the voltmeters are noted. $V_1 : V_2$ gives the turns ratio.

The beginning and end of the primary and secondary may then be marked by $A_1 - A_2$ and $a_1 - a_2$ respectively for each phase separately. If the voltage rises from A_1 to A_2 in the primary, at any instant it does so from a_1 to a_2 in the secondary.

2 Marks for procedure

For the polarity as shown, the voltmeter reading must show $V_3 = V_1 - V_2$ called subtractive polarity. If voltmeter reads $V_3 = V_1 + V_2$ (Additive polarity) Polarity marking shown should be reversed. Same procedure will be repeated for remaining two phases.

6 Attempt any FOUR of the following: 16

6 a) Describe the method of converting three phase to two phase transformer by neat diagram

6 a) Ans:

Scott connection of transformers:

Used for three phase to two phase conversion when two phase loads such as furnaces/ electric traction of large ratings are to be used so that the large load gets distributed equally on the three phases to have balanced load condition.

- can also be used for two phase to 3 phase transformation. Two transformers which have turns rated as shown are used. T_1= teaser transformer, T_2= Main transformer

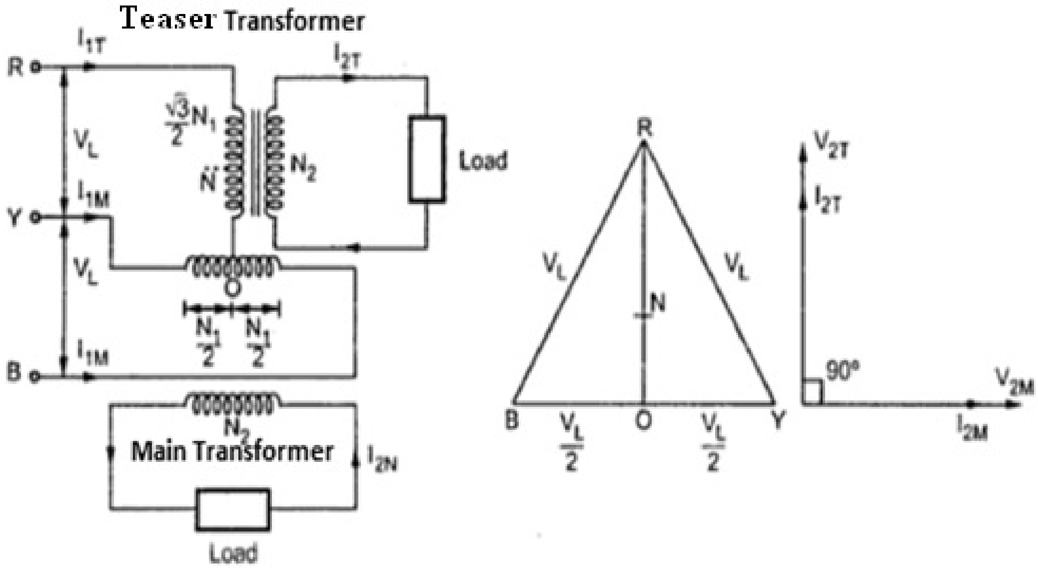


Figure (or equivalent) 2 Marks

-Teaser transformer primary has √3/ 2 times the turns of main primary. But volt /turn is same.

-The secondary's have same turns.

- The main transformation ratio is N_2/ N_1 and that of teaser is 1.15 N_2/ N_1 .

- If the Load is balanced on one side , It is balanced on other side also. 2 Marks (description)

- under balanced load condition, Main transformer rating is 15 % greater than teaser.

- The currents in either side of two halves of main primary are the vector sum of KI_{2M} and 0.58 KI_{2T}.

6 b) Describe working of isolation transformer.

6 b Ans:

Working of Isolation transformer-

Working of isolation transformer based on Mutual induction similar to ordinary transformer. 1 Mark

This Transformer has a ratio of 1:1 between the primary and secondary windings are often used to protect secondary circuits. 1 Mark

-An **isolation transformer** is a transformer used to transfer electrical power from a source of alternating current (AC) power to some equipment or device while isolating the Primary circuit to secondary circuit, usually for safety reasons.- A transformer used for isolation is built with special insulation between primary and secondary. 1 Mark

-Isolation transformers block transmission of the DC component in signals from one circuit to the other, but allow AC components in signals to pass. Isolation transformers with electrostatic shields are used for power supplies for sensitive equipment such as computers, medical devices, or laboratory instruments. 1 Mark

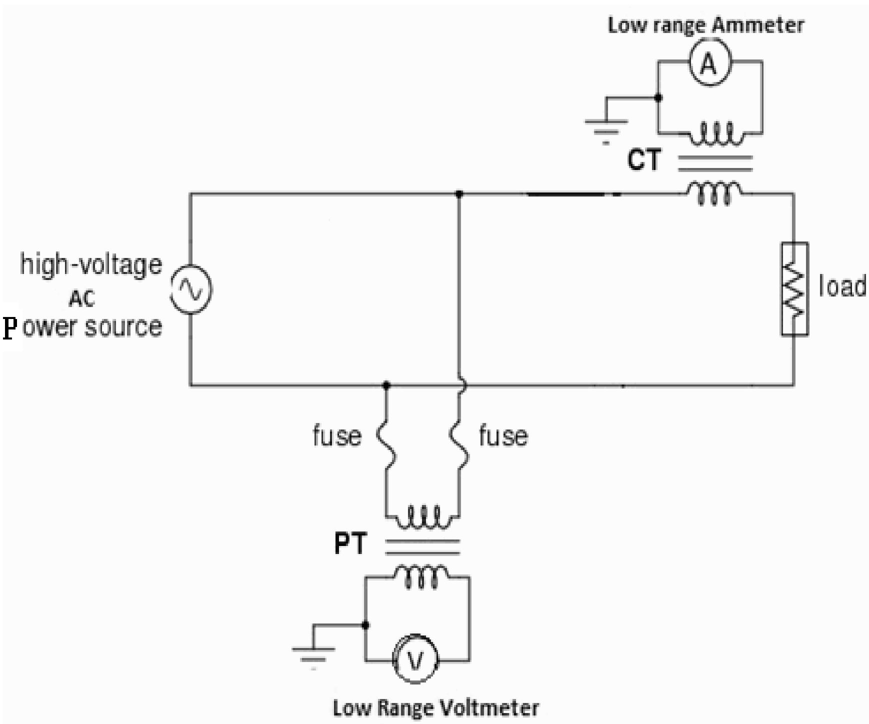
6 c) List any four advantages of 1 Ø Autotransformer.

6 c) **Advantages of 1 ph autotransformer :**

i) Reduction in copper required — 1 Mark each (Any Four)
ii) Cost is Low.
iii) The Size is reduced
iv) Losses are reduced
v) high efficiency.
vi) Better Voltage regulation
vii) Variable output voltage.

6 d) Draw circuit diagram of connected CT and PT in a 1 phase circuit.

6 d **Circuit diagram for P.T and C.T.:**



2 Mark for C. T. Connection

2 Marks for P. T. Connection

6 e) Compare single phase autotransformer with two winding transformer on basis of no. of windings, copper loss, voltage regulation and cost.

6 e Ans:

Point	Two winding transformer	Auto transformer
No. of windings	Different primary & secondary winding = 2 windings	Primary & secondary turns in same winding = 1 winding only.
Copper losses	More	Lower
Voltage regulation	Good	Better
Cost	More costly for same capacity	Less cost

1 Mark each

6 f) List special features of welding transformer.

6 f **Ans:**

Special features of welding transformer:

i) It is a step down transformer that reduces the voltage from the source voltage to a voltage desired according to the demands of the welding process.

1 Mark each (any Four)

ii)Having large primary turns and less secondary turns.

iii)The secondary current is quite high.

iv)The secondary has several taps for adjusting the secondary voltage to control the welding current.

v)The transformer is normally large in size compared to other step down transformers as the windings are of a much larger gauge.

vi)Common ratings:

Primary voltage – 230 V, 415 V
Secondary voltage – 40 to 60 V
Secondary current – 200 to 600 A