SSC-JE

Staff Selection Commission

Junior Engineer

Electrical Engineering

Topicwise Objective Solved Questions

Previous Years Solved Papers : 2007-2019

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SSC-Junior Engineer : Electrical Engineering Previous Year Solved Papers

First Edition: 2016

Second Edition: 2018

Third Edition: 2019

Fourth Edition: 2020

Preface

B. Singh (Ex. IES)

Staff Selection Commission-Junior Engineer has always been preferred by Engineers due to job stability. SSC-Junior Engineer examination is conducted every year. MADE EASY team has deeply analyzed the previous exam papers and observed that a good percentage of questions are repetitive in nature, therefore it is advisable to solve previous years papers before a candidate takes the exam.

The SSC JE exam is conducted in two stages as shown in table given below.

Papers	Subject	Maximum Marks	Duration
Stage 1: Paper-I : Objective type	(i) General Intelligence & Reasoning (ii) General Awareness (iii) General Engineering : Mechanical	50 Marks 50 Marks 100 Marks	2 hours
Stage 2: Paper-II : Conventional Type	General Engineering : Mechanical	300 Marks	2 hours
Note: In Paper-I, every question carry one mark and there is negative marking of ¼ marks for every wrong answer. Candidates shortlisted in Stage 1 are called for Stage 2. On the basis of combined score in Stage 1 and Stage 2, final merit list gets prepared.			

MADE EASY has taken due care to provide complete solution with accuracy. Apart from Staff Selection Commission-Junior Engineer, this book is also useful for Public Sector Examinations and other competitive examinations for engineering graduates.

I have true desire to serve student community by providing good source of study and quality guidance. Any suggestion from the readers for improvement of this book is most welcome.

With Best Wishes

B. Singh

CMD, MADE EASY

Syllabus of Engineering Subjects

(For both Objective and Conventional Type Papers)

Electrical Engineering

Basic concepts: Concepts of resistance, inductance, capacitance, and various factors affecting them. Concepts of current, voltage, power, energy and their units.

Circuit law: Kirchhoff's law, Simple Circuit solution using network theorems.

Magnetic Circuit: Concepts of flux, mmf, reluctance, Different kinds of magnetic materials, Magnetic calculations for conductors of different configuration e.g. straight, circular, solenoidal, etc. Electromagnetic induction, self and mutual induction.

AC Fundamentals: Instantaneous, peak, R.M.S. and average values of alternating waves, Representation of sinusoidal wave form, simple series and parallel AC Circuits consisting of R, L and C, Resonance, Tank Circuit. Poly Phase system – star and delta connection, 3-phase power, DC and sinusoidal response of R-Land R-C circuit.

Measurement and Measuring Instruments: Measurement of power (1 phase and 3-phase, both active and re-active) and energy, 2 wattmeter method of 3-phase power measurement. Measurement of frequency and phase angle. Ammeter and voltmeter (both moving oil and moving iron type), extension of range wattmeter, Multimeters, Megger, Energy meter AC Bridges. Use of CRO, Signal Generator, CT, PT and their uses. Earth fault detection.

Electrical Machines: (a) D.C. Machine – Construction, Basic Principles of D.C. motors and generators, their characteristics, speed control and starting of D.C. Motors. Method of braking motor, Losses and efficiency of D.C. Machines. (b) 1 phase and 3 phase transformers – Construction, Principles of operation, equivalent circuit, voltage regulation, O.C. and S.C. Tests, Losses and efficiency. Effect of voltage, frequency and wave form on losses. Parallel operation of 1 phase /3 phase transformers. Auto transformers. (c) 3 phase induction motors, rotating magnetic field, principle of operation, equivalent circuit, torque-speed characteristics, starting and speed control of 3 phase induction motors. Methods of braking, effect of voltage and frequency variation on torque speed characteristics. Fractional Kilowatt Motors and Single Phase Induction Motors: Characteristics and applications.

Synchronous Machines: Generation of 3-phase e.m.f. armature reaction, voltage regulation, parallel operation of two alternators, synchronizing, control of active and reactive power. Starting and applications of synchronous motors.

Generation, Transmission and Distribution: Different types of power stations, Load factor, diversity factor, demand factor, cost of generation, inter-connection of power stations. Power factor improvement, various types of tariffs, types of faults, short circuit current for symmetrical faults. Switchgears – rating of circuit breakers, Principles of arc extinction by oil and air, H.R.C. Fuses, Protection against earth leakage/over current, etc. Buchholtz relay, Merz-Price system of protection of generators & transformers, protection of feeders and bus bars. Lightning arresters, various transmission and distribution system, comparison of conductor materials, efficiency of different system. Cable – Different type of cables, cable rating and derating factor.

Estimation and Costing: Estimation of lighting scheme, electric installation of machines and relevant IE rules. Earthing practices and IE Rules.

Utilization of Electrical Energy: Illumination, Electric heating, Electric welding, Electroplating, Electric drives and motors.

Basic Electronics: Working of various electronic devices e.g. P N Junction diodes, Transistors (NPN and PNP type), BJT and JFET. Simple circuits using these devices.

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SSC-JE

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CHAPTER

3

Paper - I : Objective

Electrical Machines

1. Transformers

1.1 A 100 V/10 V, 50 VA transformer is converted to 100 V/ 110 V autotransformer, the rating of the autotransformer will be

(a) 550 VA (b) 500 VA
(c) 110 VA (d) 100 VA

[SSC-JE : 2007]

1.2 A transformer has maximum efficiency at full load, when iron losses are 800 watts, copper losses at half load will be

(a) 1600 W (b) 800 W
(c) 400 W (d) 200 W

[SSC-JE : 2007]

1.3 The purpose of the conservator in a transformer is

(a) to cool the winding.
(b) to prevent moisture in the transformer.
(c) to prevent short circuit of primary and secondary winding.
(d) to take up contraction and expansion of oil.

[SSC-JE : 2008]

1.4 In case of a power transformer, the no load current in terms of rated current is

(a) 10 to 20% (b) 2 to 6%
(c) 15 to 30% (d) 30 to 50%

[SSC-JE : 2008]

1.5 If copper loss of transformer at $\frac{7}{8}$th full load is 4900 W, then its full load copper loss would be

(a) 5600 W (b) 6400 W
(c) 373 W (d) 429 W

[SSC-JE : 2008]

1.6 If a 500 kVA, 200 Hz transformer is operated at 50 Hz, its KVA rating will be

(a) 2000 KVA (b) 125 KVA
(c) 250 KVA (d) 1000 KVA

[SSC-JE : 2009]

1.7 The power factor at which transformer operates

(a) is unity
(b) is 0.8 lag
(c) is 0.8 lead
(d) depends upon the power factor of the load

[SSC-JE : 2009]

1.8 The efficiency at a 100 KVA transformer is 0.98 at full as well as half load. For this transformer at full load the copper loss

(a) is less than core loss.
(b) is equal to core loss.
(c) is more than core loss.
(d) all the above

[SSC-JE : 2009]

1.9 Which of the following will improve the mutual coupling between primary and secondary circuit?

(a) Transformer oil of high breakdown voltage
(b) High reluctance magnetic core
(c) Winding material of high resistivity
(d) Low reluctance magnetic core

[SSC-JE : 2009]

1.10 High leakage transformers are of

(a) small voltage ampere rating
(b) high voltage ampere rating
(c) high voltage rating
(d) low voltage rating [SSC-JE : 2009]

1.11 A transformer is working at its full load and its efficiency is also maximum at which iron loss is 1000 Watts. Then, its copper loss at half of full load will be:

(a) 250 Watts (b) 300 Watts
(c) 400 Watts (d) 500 Watts

[SSC-JE : 2010]

1.12 Distribution transformers are designed to have maximum efficiency nearly at:
(a) 100% of full load (b) 50% of full load
(c) 25% of full load (d) 10% of full load
[SSC-JE : 2010]

1.13 A 2 kVA transformer has iron loss of 150 W and full load copper loss of 250 W. The maximum efficiency of the transformer will occur when the total loss is:
(a) 500 W (b) 400 W
(c) 300 W (d) 275 W
[SSC-JE : 2010]

1.14 A 20 kVA, 2000 V / 200 V, 2-winding transformer, when used as an autotransformer, with constant voltage source of 2000 V, is capable of handling
(a) 20 kVA (b) 220 kVA
(c) 320 kVA (d) None of these
[SSC-JE : 2011]

1.15 Power transformers are designed such that maximum efficiency occurs at
(a) half of the full load
(b) near full load
(c) $1/4^{th}$ of full load
(d) $3/4^{th}$ of full load
[SSC-JE : 2011]

1.16 In a 1-phase transformer, the copper loss at full load is 600 Watts. At half of the full load the copper loss will be
(a) 150 Watts (b) 75 Watts
(c) 600 Watts (d) 300 Watts
[SSC-JE : 2012]

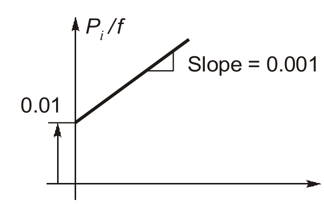
1.17 In autotransformer, the number of turns in primary winding is 210 and in secondary winding is 140. If the input current is 60 A, the currents in output and in common winding are respectively
(a) 40 A, 20 A (b) 40 A, 100 A
(c) 90 A, 30 A (d) 90 A, 150 A
[SSC-JE : 2012]

1.18 A 3-phase transformer has its primary connected in delta and secondary in star. Secondary to primary turns ratio per phase is 6. For a primary voltage of 200 V, the secondary voltage would be
(a) 2078 V (b) 693 V
(c) 1200 V (d) 58 V
[SSC-JE : 2012]

1.19 The iron loss in a 100 KVA transformer is 1 kW and full load copper losses are 2 kW. The maximum efficiency occurs at a load of
(a) 100 KVA (b) 70.7 KVA
(c) 141.4 KVA (d) 50 KVA
[SSC-JE : 2012]

1.20 The iron loss per unit frequency in a ferromagnetic core, when plotted against frequency, is a
(a) Straight line with positive slope
(b) Straight line with negative slope
(c) Parabola
(d) Constant
[SSC-JE : 2012]

1.21 Following graph shows the loss characteristic of a sheet of ferromagnetic material against varying frequency f. P_i is the iron loss at frequency f. Hysteresis and eddy current losses of the sheet at 100 Hz are



(a) 10 W, 100 W (b) 10 W, 50 W
(c) 1 W, 5 W (d) 1 W, 10 W
[SSC-JE : 2012]

1.22 Eddy current loss in ferromagnetic core is proportional to
(a) square of frequency
(b) square root of frequency
(c) frequency
(d) reciprocal of frequency
[SSC-JE : 2012]

1.23 If the frequency of input voltage of a transformer is increased keeping the magnitude of the voltage unchanged, then
(a) both hysteresis loss and eddy current loss in the core will increase.
(b) hysteresis loss will increase but eddy current loss will decrease.
(c) hysteresis loss will decrease but eddy current loss will remain unchanged.
(d) hysteresis loss will decrease but eddy current loss will increase.
[SSC-JE : 2013]

1.24 The high-voltage and low-voltage winding resistances of a distribution transformer of 100 KVA, 1100/220 volts, 50 Hz are 0.1 Ω and 0.004 Ω respectively. The equivalent resistances referred to high-voltage side and low-voltage side are respectively
(a) 2.504 Ω and 0.2 Ω
(b) 0.2 Ω and 0.008 Ω
(c) 0.10016 Ω and 2.504 Ω
(d) 0.008 Ω and 0.10016 Ω [SSC-JE : 2013]

1.25 Low voltage windings are placed nearer to the core in the case of concentric windings because
(a) it reduces hysteresis loss.
(b) it reduces eddy current loss.
(c) it reduces insulation requirement.
(d) it reduce leakage fluxes.
[SSC - JE : 2014 (FN)]

1.26 If K is the phase-to-phase voltage ratio, then the line-to-line voltage ratio in a 3-phase, Y-Δ transformer is
(a) K (b) $\frac{K}{\sqrt{3}}$
(c) $\sqrt{3}K$ (d) $\frac{\sqrt{3}}{K}$
[SSC - JE : 2014 (FN)]

1.27 In an autotransformer of voltage ratio $\frac{V_1}{V_2}, V_1 > V_2$, the fraction of power transferred inductively is proportional to
(a) $\frac{V_1}{(V_2+V_2)}$ (b) $\frac{V_2}{V_1}$
(c) $\frac{(V_1-V_2)}{(V_1+V_2)}$ (d) $\frac{(V_1-V_2)}{V_1}$
[SSC - JE : 2014 (FN)]

1.28 Stepped core is used in transformers in order to reduce
(a) volume of iron (b) volume of copper
(c) iron loss (d) reluctance of core
[SSC - JE : 2014 (FN)]

1.29 A delta-star transformer has phase to phase voltage transformation ratio of a : 1 [delta phase: star phase]. The line to line voltage ratio of star-delta is given by:
(a) $\frac{a}{1}$ (b) $\frac{\sqrt{3}}{\sqrt{a}}$
(c) $a\frac{\sqrt{3}}{1}$ (d) $\frac{\sqrt{3}}{a}$
[SSC - JE : 2014 (AN)]

1.30 A 10 Ω resistive load is to be impedance matched by a transformer to a source with 6250 Ω of internal resistance. The ratio of primary to secondary turns of transformer should be
(a) 25 (b) 10
(c) 15 (d) 20
[SSC - JE : 2014 (AN)]

1.31 The primary and secondary windings of a transformer are wound on the top of each other in order to reduce _____ .
(a) iron losses (b) winding resistance
(c) copper losses (d) leakage reactance
[SSC-JE : 2015]

1.32 The no load input power to a transformer is practically equal to _____ loss in the transformer.
(a) Copper (b) Eddy current
(c) Iron (d) Windage
[SSC-JE : 2015]

1.33 The no load primary current I_0 is about ____ of full load primary current of a transformer.
(a) above 40% (b) 30 - 40%
(c) 15 - 30% (d) 3 - 5%
[SSC-JE : 2015]

1.34 Leakage flux in a transformer occurs because,
(a) transformer is not an efficient device.
(b) applied voltage is sinusoidal.
(c) air is not a good magnetic insulator.
(d) iron core has high permeability.
[SSC-JE : 2015]

1.35 The load carried by V-V connection is ______.
(a) 47.7% of the original load
(b) 57.7% of the original load
(c) 67.7% of the original load
(d) 87.7% of the original load
[SSC-JE (Forenoon) 1.3.2017]

1.36 If the AC supply to transformer is replaced by DC ______.
(a) the primary winding will burn
(b) the secondary winding will burn
(c) the transformer has no effect
(d) all options are correct
[SSC-JE (Forenoon) 1.3.2017]

1.37 For a 100% efficient transformer, the primary winding has 1000 turns and the secondary 100 turns. If the power input to the above transformer is 1000 Watts, the power output is ______.
(a) 1000 Watts (b) 100 Watts
(c) 10 Watts (d) 10 kW
[SSC-JE (Afternoon) 1.3.2017]

1.38 What is the efficiency of transformer compared with that of electrical motor of the same power?
(a) Much smaller (b) Somewhat smaller
(c) About same (d) Much higher
[SSC-JE (Afternoon) 1.3.2017]

1.39 A transformer has a core loss of 64 W and copper loss of 144 W, when it is carrying 20% overload current. The load at which this transformer will operate at the maximum efficiency ______.
(a) 80% (b) 66%
(c) 120% (d) 44%
[SSC-JE (Forenoon) 2.3.2017]

1.40 Which of the following transformers is smallest?
(a) 1 kVA, 50 Hz (b) 1 kVA, 200 Hz
(c) 1 kVA, 400 Hz (d) 1 kVA, 600 Hz
[SSC-JE (Forenoon) 2.3.2017]

1.41 Two transformers operating in parallel will share the load depending upon their ______.
(a) efficiency also
(b) ratings also
(c) leakage resistance
(d) none of these
[SSC-JE (Forenoon) 2.3.2017]

1.42 The short circuit test in a transformer is used to determine ______.
(a) iron loss at any load
(b) copper loss at any load
(c) hysteresis loss
(d) eddy current
[SSC-JE (Forenoon) 2.3.2017]

1.43 Under heavy loads, transformer efficiency is comparatively low because
(a) voltage drops both in primary and secondary become large.
(b) secondary output is much less as compared to primary input.
(c) copper loss becomes high in proportion to the output.
(d) iron loss is increased considerably.
[SSC-JE (Forenoon) 2.3.2017]

1.44 In relation to a transformer the ratio 20 : 1 indicates that,
(a) there are 20 turns on primary and one turn on secondary.
(b) secondary voltage is $l/20^{th}$ of primary voltage.
(c) primary current is 20 times greater than secondary current.
(d) for every 20 turns on primary, there is one turn on secondary.
[SSC-JE (Forenoon) 2.3.2017]

1.45 The main purpose of using core in a transformer is to ______.
(a) decrease iron losses
(b) prevent eddy current loss
(c) eliminate magnetic hysteresis
(d) decrease reluctance of the common magnetic circuit
[SSC-JE (Afternoon) 2.3.2017]

1.46 The current transformer that is used to measure a 100 A current by 5 A ammeter is a ______.
(a) step up transformer
(b) step down transformer
(c) power transformer
(d) distribution transformer
[SSC-JE (Afternoon) 2.3.2017]

1.47 Centrifugal methods of reconditioning transformer oil is effective for removal of ______.
(a) water (b) dissolved gases
(c) solid impurities (d) all options are correct
[SSC-JE (Afternoon) 2.3.2017]

1.48 Compared to the secondary of a loaded step-up transformer, the primary has ______.
(a) lower voltage and higher current
(b) higher voltage and lower current
(c) lower voltage and lower current
(d) higher voltage and higher current
[SSC-JE (Forenoon) 3.3.2017]

1.49 Under operating conditions the secondary of a current transformer is always short circuited because ________.
(a) It protects the primary circuits
(b) It is safe for human beings
(c) It avoids core saturation and high voltage induction
(d) None of these
[SSC-JE (Forenoon) 3.3.2017]

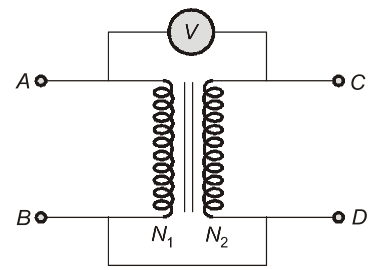
1.50 During short-circuit test, the iron loss of a transformer is negligible because ______.
(a) the entire input is just sufficient to meet copper losses only
(b) voltage applied across the HV (High Voltage) side is a small fraction of the rated voltage and so its flux
(c) iron core becomes fully saturated
(d) supply frequency is held constant
[SSC-JE (Forenoon) 3.3.2017]

1.51 When a 400 Hz transformer is operated at 50 Hz, its kVA rating is _____.
(a) reduced to 1/8
(b) increased 8 times
(c) unaffected
(d) determined by load on secondary
[SSC-JE (Forenoon) 3.3.2017]

1.52 The ordinary efficiency of a given transformer is maximum when _______.
(a) it runs at half full- load
(b) it runs at full-load
(c) its copper loss equals iron loss
(d) it runs overload
[SSC-JE (Forenoon) 3.3.2017]

1.53 While conducting short-circuit test on a transformer the following side is short-circuited ______.
(a) HV side (b) LV side
(c) Primary side (d) None of these
[SSC-JE (Forenoon) 3.3.2017]

1.54 A single phase transformer is connected as shown in below figure. When a voltage of 100 V (rms) was applied across *AB*, the voltmeter connected across AC measured 100 V (rms). The turns ratio $N_1 : N_2$ is



(a) 1 : 2 (b) 2 : 1
(c) 1 : 4 (d) 4 : 1
[SSC-JE (Afternoon) 3.3.2017]

1.55 The advantage of putting tappings at the phase ends of a transformer is ______.
(a) to obtain fine variation of voltage
(b) to operate with ease
(c) to reduce the number of bushings
(d) to obtain better regulation
[SSC-JE (Afternoon) 3.3.2017]

1.56 What is load at which maximum efficiency occurs in case of a 100 kVA transformer with iron loss of 1 kW and full load copper loss of 2 kW?
(a) 100 kVA (b) 70.7 kVA
(c) 50.5 kVA (d) 25.2 kVA
[SSC-JE (Forenoon) 4.3.2017]

1.57 The all day efficiency of a distribution transformer will be high with low ______.
(a) copper losses
(b) iron losses
(c) operating temperature
(d) copper as well as iron losses
[SSC-JE (Forenoon) 4.3.2017]

1.58 Sludge formation in transformer oil is due to which one of the following?
(a) Ingress of dust particles and moisture in the oil.
(b) Appearance of small fragments of paper, varnish, cotton and other organic materials in the oil.
(c) Chemical reaction of transformer oil with the insulating materials.
(d) Oxidation of transformer oil.
[SSC-JE (Forenoon) 4.3.2017]

1.59 A 500 kVA transformer has constant loss of 500 W and copper losses at full load are 2000 W. Then at what load, is the efficiency maximum?
(a) 250 KVA (b) 500 kVA
(c) 1000 kVA (d) 125 kVA
[SSC-JE (Afternoon) 4.3.2017]

1.60 The all day efficiency of a transformer depends primarily on ______.
(a) its copper losses
(b) the amount of load
(c) the duration of load
(d) both the amount and duration of load
[SSC-JE (Afternoon) 4.3.2017]

1.61 In a power transformer, the breather is provided in order to
(a) filter transformer oil
(b) prevent ingress of moisture with air
(c) the cooling oil
(d) provide fresh air for increasing cooling effect
[SSC-JE (Afternoon) 4.3.2017]

1.62 The voltage regulation of a transformer having copper loss 1% of output and percentage reactance drop of 5% and power factor 0.9 lagging is _____.
(a) 3.08% (b) 3%
(c) –3.08% (d) 3.8%
[SSC-JE (Forenoon) 1.3.2017]

1.63 Secondary winding of an auto transformer is also called______.
(a) compensating winding
(b) common winding
(c) tertiary winding
(d) damping winding
[SSC-JE (Forenoon) 27.01.2018]

1.64 In which transformer, the tertiary winding is used
(a) Star - delta (b) Star - star
(c) Delta - delta (d) Delta - star
[SSC-JE (Forenoon) 27.01.2018]

1.65 Which of the following is the CORRECT expression for hysteresis loss occurring in a material?
(a) $\eta \times B_m^2 \times f^2 \times V$
(b) $\eta \times B_m^2 \times f^2 \times V^{2.5}$
(c) $\eta \times B_m^{1.6} \times f \times V$
(d) $\eta \times B_m^2 \times f^{1.6} \times V$
[SSC-JE (Forenoon) 22.01.2018]

1.66 Stepped cores are used in transformers in order to reduce
(a) volume of iron
(b) volume of copper
(c) iron loss
(d) reluctance of core
[SSC-JE (Forenoon) 22.01.2018]

1.67 In a transformer the resistance between its primary and secondary is
(a) zero (b) 1 ohm
(c) 1000 ohms (d) infinite
[SSC-JE (Forenoon) 22.01.2018]

1.68 In a transformer zero voltage regulation is achieved at a load power factor which is
(a) zero (b) leading
(c) lagging (d) Unity
[SSC-JE (Forenoon) 22.01.2018]

1.69 Tapings of a transformer are provided
(a) At the phase end of LV side
(b) At the phase end of HV side
(c) At the neutral side end of HV side
(d) At the middle of HV side
[SSC-JE (Afternoon) 22.1.2018]

1.70 In an auto-transformer a part of energy transfer is through
(a) convection process
(b) conduction process
(c) Induction process
(d) radiation process
[SSC-JE (Afternoon) 22.1.2018]

1.71 Voltage regulation of transformer is given by
(a) $\frac{(E-V)}{V}$ (b) $\frac{(E-V)}{E}$
(c) $(V-E)E$ (d) $(V-E)V$
[SSC-JE (Afternoon) 22.1.2018]

1.72 Which is the only transformer whose primary and secondary are connected to each other electrically?
(a) Shielded Winding transformer
(b) Insulating transformer
(c) Auto transformer
(d) Isolating transformer
[SSC-JE (Afternoon) 22.1.2018]

1.73 The core of the transformer is made of
(a) copper (b) aluminum
(c) air (d) laminated sheath
[SSC-JE (Afternoon) 22.1.2018]

1.74 Determine the eddy current loss (in W) in a material having eddy current coefficient of 1, thickness of 0.04 m and volume of 2 cubic metre which is kept in a magnetic field having a maximum flux density of 4 T and supplied by a frequency of 50 Hz.

(a) 140 (b) 128
(c) 108 (d) 100

[SSC-JE (Forenoon) 23.01.2018]

1.75 A 10 kVA auto transformer, turn ratio is 0.4. Find the power transferred inductively
(a) 4 kVA (b) 6 kVA
(c) 10 kVA (d) 0 kVA

[SSC-JE (Forenoon) 23.01.2018]

1.76 On parallel operation of two or more transformers the percentage impedance of transformers should be
(a) such that actual impedance of all transformers would be same
(b) same
(c) proportionate to MVA rating of transformers
(d) inversely proportional to MVA rating of transformers

[SSC-JE (Forenoon) 23.01.2018]

1.77 Scott connections are used for
(a) single phase to three phase transformation
(b) three phase to single phase transformation
(c) three phase to two phase transformation
(d) any of the above

[SSC-JE (Afternoon) 23.01.2018]

1.78 The primary and secondary windings of an Auto transformer are
(a) magnetically coupled
(b) electrically coupled
(c) both magnetically and electrically coupled
(d) None of these

[SSC-JE (Afternoon) 23.01.2018]

1.79 A 40 kVA transformer has a core loss of 450 W and total loss of 800 W. Find the copper loss for Maximum efficiency.
(a) 350 W (b) 800 W
(c) 450 W (d) None of these

[SSC-JE (Afternoon) 23.01.2018]

1.80 Determine the maximum flux density (in T) of a material having eddy current coefficient of 2, thickness of 4 mm, volume of 20 cu. meter, which is supplied by a frequency of 50 Hz when the material has eddy current loss of 600 W.
(a) 2.24 (b) 3.34
(c) 1.94 (d) 1.21

[SSC-JE (Afternoon) 23.01.2018]

1.81 Which of the following is the CORRECT expression for the eddy current loss occurring in a material?
(a) $K \times B_m^2 \times f^2 \times t^2 \times V$
(b) $\eta \times B_m^2 \times f^2 \times V$
(c) $K \times B_m^2 \times f \times t \times V$
(d) $K \times B_m^{1.6} \times f^2 \times t \times V$

[SSC-JE (Forenoon) 24.1.2018]

1.82 Transformers operating in parallel will share the load depends upon
(a) rating
(b) leakage reactance
(c) efficiency
(d) percentage impedance

[SSC-JE (Forenoon) 24.1.2018]

1.83 The working principle of transformer depends on
(a) Coulomb's law (b) Faraday's law
(c) Ampere's law (d) Newton's law

[SSC-JE (Forenoon) 24.1.2018]

1.84 The heat generated in the transformer is dissipated mainly by
(a) conduction (b) convection
(c) radiation (d) All option are correct

[SSC-JE (Forenoon) 24.1.2018]

1.85 A Transformer
(a) Changes AC to DC.
(b) Changes DC to AC.
(c) Steps up or down D C Voltages & Current
(d) Steps up or down AC Voltages & Current.

[SSC-JE (Afternoon) 24.01.2018]

1.86 The overall power factor of an On-load transformer
(a) depends on the power factor of the load.
(b) is always lagging.
(c) is always unity.
(d) is always leading.

[SSC-JE (Afternoon) 24.01.2018]

1.87 Maximum efficiency will occur, when copper loss and iron loss are
(a) unity (b) zero
(c) unequal (d) equal

[SSC-JE (Afternoon) 24.01.2018]

1.88 Calculate the value of flux leakage coefficient, if ϕ_g is the air gap flux and ϕ_a is the flux in iron core.
(a) ϕ_g / ϕ_a (b) ϕ_a / ϕ_g
(c) $\phi_a \times \phi_g$ (d) $\phi_a + \phi_g$
[SSC-JE (Forenoon) 25.01.2018]

1.89 Breather is provided in a transformer to
(a) Absorb moisture of air during breathing.
(b) Provide cold air in transformer
(c) Absorb moisture from air entering in transformer
(d) Filter the transformer oil.
[SSC-JE (Forenoon) 25.01.2018]

1.90 The primary and secondary windings of a transformer are
(a) Conductively linked
(b) Inductively linked
(c) Electrically linked
(d) Mechanically linked
[SSC-JE (Forenoon) 25.01.2018]

1.91 Which of the following is not a part of transformer?
(a) Commutator (b) Conservator tank
(c) Radiator (d) Tap changer
[SSC-JE (Forenoon) 25.01.2018]

1.92 A short circuit test on a transformer gives
(a) copper loss at full load
(b) copper loss at any load
(c) copper loss at half load
(d) copper loss at over load
[SSC-JE (Afternoon) 25.1.2018]

1.93 A step up transformer increases______.
(a) power (b) voltage
(c) frequency (d) current
[SSC-JE (Afternoon) 25.1.2018]

1.94 Hysteresis loss occurring in a material does NOT depend on which of the following parameters?
(a) Hysteresis constant
(b) Magnetic flux density
(c) Frequency
(d) Reluctivity
[SSC-JE (Forenoon) 27.01.2018]

1.95 Determine the eddy current loss (in W) in a material having eddy current coefficient of 1, thickness of 0.02 m and a volume of 1 cubic metre, which is kept in a magnetic field of maximum flux density of 2T and supplied by a frequency of 50 Hz.
(a) 2 (b) 3
(c) 4 (d) 5
[SSC-JE (Forenoon) 27.01.2018]

1.96 The no load current in a transformer is
(a) Sinusoidal (b) non Sinusoidal
(c) Trapezoidal (d) stepped
[SSC-JE (Forenoon) 27.01.2018]

1.97 Transformer cooling and insulation oil must be of
(a) low viscosity (b) high viscosity
(c) low BDV (d) low resistivity
[SSC-JE (Forenoon) 27.01.2018]

1.98 Single Phase transformers can be used in parallel only when their voltages are
(a) Equal (b) Unequal
(c) Zero (d) None of these
[SSC-JE (Forenoon) 27.01.2018]

1.99 On which of the following parameters the eddy current loss occurring in a material does not depend?
(a) Magnetic flux Density
(b) Frequency of variation of flux
(c) Susceptibility
(d) Volume of the material
[SSC-JE (Afternoon) 27.1.2018]

1.100 Determine the eddy current loss (in W) in a material having eddy current coefficient of 1, thickness of 0.03 m and volume of 2 cubic metre which is kept in a magnetic field of maximum flux density of 3 T and supplied by a frequency of 50 Hz.
(a) 35.5 (b) 30.5
(c) 25.5 (d) 40.5
[SSC-JE (Afternoon) 27.1.2018]

1.101 Transformer oil is used as
(a) An insulator
(b) A coolant
(c) both insulator and coolant
(d) inert medium
[SSC-JE (Afternoon) 27.1.2018]

1.102 Which is to be short circuited on performing short circuit test on a transformer?
(a) Low voltage side (b) High voltage side
(c) Primary side (d) secondary side
[SSC-JE (Afternoon) 27.1.2018]

1.103 A Single Phase 50Hz transformer has high voltage and low voltage windings of 2200/220 V. What is the Transformation ratio?
(a) 10 (b) 1/10
(c) 1 (d) None of these
[SSC-JE (Afternoon) 27.1.2018]

1.104 An Isolation Transformer Has Primary to Secondary turns ratio of
(a) 1 : 2 (b) 2 : 1
(c) 1 : 1 (d) Can be any ratio
[SSC-JE (Forenoon) 29.1.2018]

1.105 Input of a transformer is square wave, then the output will be
(a) pulsed wave(b) square wave
(c) triangular wave (d) sine wave
[SSC-JE (Forenoon) 29.1.2018]

1.106 Total core loss is also referred as
(a) eddy current loss (b) Hysteresis Loss
(c) Magnetic Loss (d) Copper Loss
[SSC-JE (Forenoon) 29.1.2018]

1.107 The magnitude of the induced emf in the primary winding, will be __________ but opposite to the applied voltage.
(a) higher (b) almost equal
(c) lower (d) negligible
[SSC-JE (Forenoon) 29.1.2018]

1.108 In case of core type transformer which type of winding is done near the core?
(a) Low voltage (b) High voltage
(c) Primary winding (d) Secondary winding
[SSC-JE (Forenoon) 29.1.2018]

1.109 The use of higher flux density in the transformer design
(a) reduce s the weight per KVA
(b) increases the weight per KVA
(c) has no relation with the weight of transformer
(d) None of these
[SSC-JE (Afternoon) 29.1.2018]

1.110 The core flux in transformer depends mainly on
(a) Supply voltage
(b) Supply voltage , Frequency and Load
(c) Supply voltage and Load
(d) Supply voltage and Frequency
[SSC-JE (Afternoon) 29.1.2018]

1.111 The type of oil used in transformer is
(a) olive (b) coconut
(c) mineral (d) palm
[SSC-JE (Afternoon) 29.1.2018]

1.112 The transformer used for AC welding sets is
(a) Booster type
(b) Step up transformer
(c) Step down transformer
(d) None of these
[SSC-JE (Afternoon) 29.1.2018]

1.113 What would the total loss of the 2 kVA trans former corresponding to maximum efficiency be, provided the transformer has iron loss of 150 W and full-load copper loss of 250 W?
(a) 500 W (b) 400 W
(c) 100 W (d) 300 W
[SSC-JE : (Forenoon) 26.9.2019]

1.114 If the copper loss of a transformer at half full load is 400 W, then the copper loss corresponding to full load is:
(a) 400 W (b) 800 W
(c) 1200 W (d) 1600 W
[SSC-JE : (Forenoon) 26.9.2019]

1.115 Which of the following losses is together called iron losses?
(a) Hysteresis loss and frictional loss
(b) Hysteresis loss and copper loss
(c) Eddy current and hysteresis loss
(d) Eddy current and loss and frictional loss
[SSC-JE : (Forenoon) 26.9.2019]

1.116 If a transformer has $N_1 : N_2 = 1 : 1$, then the transformer is a/an _____.
(a) isolation transformer
(b) current transformer
(c) potential transformer
(d) power transformer
[SSC-JE : (Afternoon) 26.9.2019]

1.117 Hysteresis loss is NOT a function of ________
(a) frequency
(b) volume of a material
(c) Steinmetz co-efficient of a material
(d) ambient temperature
[SSC-JE : (Forenoon) 26.9.2019]

1.118 An ideal transformer will not transform :
I. Power II. Current
III. Frequency IV. Voltage
(a) I and III (b) I and II
(c) II and III (d) III and IV
[SSC-JE : (Afternoon) 26.9.2019]

2. DC Machines

2.1 Which motor has the poorest speed control?
(a) Differentially compound motor
(b) Cumulatively compound motor
(c) Shunt motor
(d) Series motor
[SSC-JE : 2007]

2.2 Two d.c. series motors are connected in series to produce a torque T. Now if the motors are connected in parallel, the torque produced will be
(a) $T/4$ (b) $T/2$
(c) $2\ T$ (d) $4\ T$
[SSC-JE : 2007]

2.3 Which dc motor is generally preferred for cranes and hoists?
(a) Series motor
(b) Shunt motor
(c) Cumulatively compound motor
(d) Differentially compound motor
[SSC-JE : 2007]

2.4 Which motor has widest variety of methods for speed control?
(a) DC shunt motor
(b) Synchronous motor
(c) Slip-ring induction motor
(d) Schrage motor
[SSC-JE : 2007]

2.5 For battery charging, which of the following DC generators is used?
(a) DC series generator
(b) DC shunt generator
(c) Short shunt compound generator
(d) Long shunt compound generator
[SSC-JE : 2008]

2.6 The no load speed of DC series motor is
(a) very small (b) medium
(c) very high (d) small
[SSC-JE : 2008]

2.7 Interpoles are meant for
(a) increasing the speed of the motor.
(b) increasing counter emf.
(c) strengthening the main field.
(d) reducing sparking at the commutator.
[SSC-JE : 2008]

2.8 A 4 pole, 1200 rpm DC lap wound generator has 1520 conductors. If the flux per pole is 0.01 Weber, the emf of generator is
(a) 608 volts (b) 304 volts
(c) 152 volts (d) 76 volts
[SSC-JE : 2010]

2.9 The condition for a maximum power output from dc motor is
(a) $E_b = V$ (b) $E_b = \frac{V}{2}$
(c) $E_b = 0$ (d) $E_b = \frac{V}{\sqrt{2}}$
[SSC-JE : 2010]

2.10 In Swinburne's method of testing dc machines, the shunt machine is run as a
(a) motor at full load at rated speed and rated voltage.
(b) generator at full load at rated speed and rated voltage.
(c) generator at no load at rated speed and rated voltage.
(d) motor at no load at rated speed and rated voltage.
[SSC-JE : 2011]

2.11 The brushes of a dc machine should be physically placed on the
(a) armature in the polar axis.
(b) armature in the interpolar axis.
(c) commutator in the polar axis.
(d) commutator in the interpolar axis.
[SSC-JE : 2011]

Answers Electrical Machines

1. Transformers

1.1	(a)	1.2	(d)	1.3	(d)	1.4	(b)	1.5	(b)	1.6	(b)	1.7	(d)	1.8	(c)
1.9	(d)	1.10	(a)	1.11	(a)	1.12	(b)	1.13	(c)	1.14	(b)	1.15	(b)	1.16	(a)
1.17	(c)	1.18	(a)	1.19	(b)	1.20	(a)	1.21	(d)	1.22	(a)	1.23	(c)	1.24	(b)
1.25	(c)	1.26	(c)	1.27	(d)	1.28	(b)	1.29	(d)	1.30	(a)	1.31	(d)	1.32	(c)
1.33	(d)	1.34	(c)	1.35	(b)	1.36	(a)	1.37	(a)	1.38	(d)	1.39	(a)	1.40	(d)
1.41	(b)	1.42	(b)	1.43	(c)	1.44	(d)	1.45.	(d)	1.46	(a)	1.47	(d)	1.48	(a)
1.49	(c)	1.50	(b)	1.51	(a)	1.52	(c)	1.53	(b)	1.54	(a)	1.55	(c)	1.56	(b)
1.57	(d)	1.58	(d)	1.59	(a)	1.60	(d)	1.61	(b)	1.62	(a)	1.63	(b)	1.64	(b)
1.65	(c)	1.66	(c)	1.67	(d)	1.68	(b)	1.69	(d)	1.70	(b)	1.71	(a)	1.72	(c)
1.73	(d)	1.74	(b)	1.75	(b)	1.76	(b)	1.77	(c)	1.78	(c)	1.79	(c)	1.80	(d)
1.81	(a)	1.82	(d)	1.83	(b)	1.84	(b)	1.85	(d)	1.86	(a)	1.87	(d)	1.88	(b)
1.89	(a)	1.90	(b)	1.91	(a)	1.92	(a)	1.93	(b)	1.94	(d)	1.95	(c)	1.96	(b)
1.97	(a)	1.98	(a)	1.99	(c)	1.100	(d)	1.101	(c)	1.102	(a)	1.103	(b)	1.104	(c)
1.105.	(a)	1.106	(c)	1.107	(b)	1.108	(a)	1.109	(a)	1.110	(d)	1.111	(c)	1.112	(c)
1.113	(d)	1.114	(d)	1.115	(c)	1.116	(a)	1.117	(d)	1.118	(a)				

2. DC Machines

2.1	(d)	2.2	(a)	2.3	(a)	2.4	(a)	2.5	(b)	2.6	(c)	2.7	(d)	2.8	(b)
2.9	(b)	2.10	(d)	2.11	(c)	2.12	(d)	2.13	(b)	2.14	(b)	2.15	(b)	2.16	(d)
2.17	(b)	2.18	(a)	2.19	(b)	2.20	(a)	2.21	(c)	2.22	(c)	2.23	(d)	2.24	(c)
2.25	(a)	2.26	(b)	2.27	(b)	2.28	(c)	2.29	(b)	2.30	(b)	2.31	(c)	2.32	(c)
2.33	(d)	2.34	(c)	2.35	(a)	2.36	(a)	2.37	(b)	2.38	(d)	2.39	(d)	2.40	(c)
2.41	(c)	2.42	(c)	2.43	(b)	2.44	(b)	2.45	(c)	2.46	(a)	2.47	(a)	2.48	(a)
2.49	(b)	2.50	(b)	2.51	(c)	2.52	(c)	2.53	(b)	2.54	(d)	2.55	(c)	2.56	(c)
2.57	(d)	2.58	(d)	2.59	(b)	2.60	(b)	2.61	(c)	2.62	(d)	2.63	(a)	2.64	(b)
2.65	(a)	2.66	(b)	2.67	(b)	2.68	(c)	2.69	(b)	2.70	(d)	2.71	(b)	2.72	(d)
2.73	(a)	2.74	(d)	2.75	(b)	2.76	(a)	2.77	(d)	2.78	(d)	2.79	(a)	2.80	(a)
2.81	(c)	2.82	(c)	2.83	(a)	2.84	(a)	2.85	(b)	2.86	(c)	2.87	(b)	2.88	(d)
2.89	**(b, d)**	2.90	(a)	2.91	(b)	2.92	(c)	2.93	(b)	2.94	(d)	2.95	(c)	2.96	(a)
2.97	(d)	2.98	(a)	2.99	(c)	2.100	(b)	2.101	(d)	2.102	(c)	2.103	(a)	2.104	(c)
2.105	(b)	2.106	(a)	2.107	(c)	2.108	(b)	2.109	(d)	2.110	(d)	2.111	(a)	2.112	(a)
2.113	(c)	2.114	(b)	2.115	(a)	2.116	(d)	2.117	(a)	2.118	(b)	2.119	(a)	2.120	(a)
2.121	(c)	2.122	(c)	2.123	(c)	2.124	(c)	2.125	(d)	2.126	(d)	2.127	(d)	2.128	(b)

Explanations **Electrical Machines**

1. Transformers

1.1 (a)

Method 1:

$\because$ Rating of auto transformer is given as

$$S_{auto} = \left(\frac{a_{auto}}{a_{auto}-1}\right) \times S_{2\,winding}$$

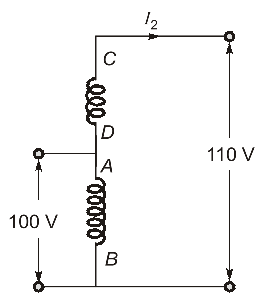
where, $a_{auto} = \frac{V_H}{V_L} = \frac{110}{100} = \frac{11}{10}$

Given, $S_{2wdg} = 50$ VA

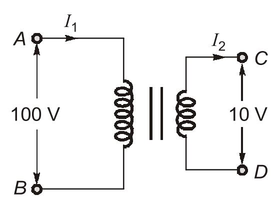
$$S_{auto} = \left[\frac{\frac{11}{10}}{\frac{11}{10}-1}\right] \cdot 50 \text{ VA}$$

$$= 11 \times 50 = 550 \text{ VA}$$

Method 2:



(Auto T/F)



(2 winding T/F)

$$I_2 = \frac{50}{10} = 5 \text{ A}$$

$$S_{auto} = 110 \times I_2 = 110 \times 5 = 550 \text{ VA}$$

1.2 (d)

For maximum efficiency (η_{max}) :

Copper loss (I^2R) = Iron loss (P_i)

So, for η_{max} at full load

$$I_{fl}^2 \cdot R = 800 \text{ W}$$

At half load, $I = \frac{I_{fl}}{2}$

$\therefore$ Copper loss at half load

$$P_{cu} = \left(\frac{I_{fl}}{2}\right)^2 \cdot R = \frac{800}{4} = 200 \text{ W}$$

1.3 (d)

Conservator is a tank placed at the top of the transformer. It controls the expansion and contraction of the transformer oil on heating and cooling process respectively.

1.4 (b)

In transformer the no load current is just 2 - 6% of full load/rated current, hence it can be neglected however it is quite considerable in the induction motor about (30-40%) of full load current hence cannot be ignored.

1.5 (b)

Copper loss P_{cu} at full load is

$$P_{cu} = I_{fl}^2 \cdot R$$

At $\frac{7}{8}$th full load, $I = \frac{7}{8} I_{fl}$

Copper loss at this load,

$$\therefore \quad \left(\frac{7}{8} I_{fl}\right)^2 \times R = 4900 \text{ W} \qquad \text{(Given)}$$

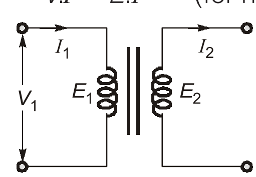
$$\Rightarrow \quad I_{fl}^2 \cdot R = 6400 \text{ Watts}$$

$$= \text{Full load copper loss}$$

1.6 (b)

The transformer rating is given as:

$$V.I = E.I \qquad \text{(for no voltage drop)}$$



$$E_1 I_1 = E_2 I_2$$

(E is induced emf.)

Since loss of voltage is neglected here, therefore

$$V = E \text{ is taken}$$

So, rating is $E \cdot I$ kVA

$\because \quad E \propto f \quad$ as $(E = \sqrt{2}\pi f \phi N)$

so, $\quad \text{kVA} \propto f$

$$\therefore \quad \frac{\text{kVA}_1}{\text{kVA}_2} = \frac{f_1}{f_2}$$

$$\Rightarrow \quad \text{kVA}_2 = \text{kVA}_1 \times \frac{f_2}{f_1} = 500 \times \frac{50}{200}$$

or, $\quad \text{kVA}_2 = 125$ kVA

1.7 (d)

The power factor at which a transformer operates depends upon the power factor of the load. If can be leading pf, lagging pf or unity pf load depending on the load connected on the secondary side of the transformer corresponding to capacitive, inductive or resistive load respectively.

1.8 (c)

Let full load copper loss in $P_{cu} = I_{fl}^2 \cdot R$

$$\text{Full load kVA} = 100 \text{ kVA}$$
$$\text{Half load kVA} = 50 \text{ kVA}$$

$$P_{cu}(\text{half load}) = \frac{P_{cu}}{4} \quad [\because P_{cu} \propto I^2]$$

Now, $$\eta = \frac{\text{output}}{\text{output} + P_i + P_{cu}}$$

∴ for full load,

$$0.98 = \frac{100}{100 + P_i + P_{cu}} \quad ...(i)$$

At half load,

$$0.98 = \frac{50}{50 + P_i + \frac{P_{cu}}{4}} \quad ...(ii)$$

(as P_i is always constant)

From equation (*i*) and (*ii*),

$$P_i = 0.68 \text{ kW}$$
$$P_{cu} = 1.36 \text{ kW} \quad (\text{full load})$$
$$\therefore \quad P_{cu} > P_i$$

1.9 (d)

$$\because \quad \text{flux } (\phi) = \frac{\text{mmf}}{\text{Reluctance}}$$

If the reluctance of the path is low in a coupled circuit, then mutual flux will be more hence the mutual coupling will get improved.

Lower the reluctance, lesser will be the opposition to flux through the transformer core. Hence the core is made of high permeability material.

[SSC-JE : 2009]

1.10 (a)

- Leakage transformers are those where magnetic flux of secondary is loosely coupled to the flux of primary.
- They are used in extra low voltage applications where short circuit conditions are expected.
  Hence, the VA rating is low.
- These types of transformers are used for some negative resistance applications such as neon signs, are welding sets.

1.11 (a)

The iron loss at full load is 1000 Watts and maximum efficiency is obtained at full load.

For maximum efficiency

∴ Full load copper loss

$$= I_{fl}^2 \cdot R = 1000 \text{ Watts}$$
$$= \text{iron loss}$$

∴ Half load copper loss

$$= \left(\frac{I_{fl}}{2}\right)^2 \times R$$
$$= \frac{1000}{4} = 250 \text{ Watts}$$

1.12 (b)

A distribution transformer has an average loading of 50-70% of full load and depends on consumer. Hence, these transforms are designed to have maximum efficiency at around 50-70% of full load (strictly at 70-75% of full load).

1.13 (c)

For maximum efficiency

$$P_{cu} = P_i$$

(i.e. variable copper loss = iron loss)

i.e. at η_{max},

$$\text{Total loss} = P_i + P_{cu}$$
$$= P_i + P_i = 2P_i$$
$$\therefore \quad \text{Total loss} = 2 \times 150 \text{ W} = 300 \text{ W}$$

1.14 (b)

Method-1:

For additive polarity connection, the voltage ratio will be equal to $\frac{2000}{2200}$.

Since, $a_{auto} > 1$

So, $a_{auto} = \frac{11}{10}$

∴ Rating of auto transformer is

$$S_{auto} = \left(\frac{a_{auto}}{a_{auto} - 1}\right) \times S_{2\,W}$$

or, $$S_{auto} = \left(\frac{11/10}{\frac{11}{10} - 1}\right) \times 20 \text{ kVA} = 220 \text{ kVA}$$

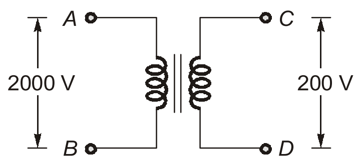
Note: For subtractive polarity $\left(\frac{2000}{1800}\right) = a_{auto}$

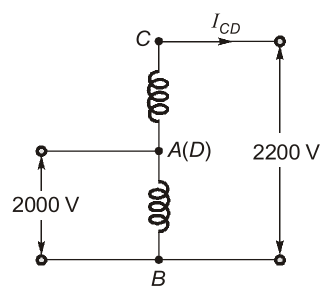
$$\therefore \quad a_{auto} = \frac{10}{9} (> 1)$$

$$\therefore \quad S_{auto} = \left(\frac{10/9}{\frac{10}{9}-1}\right) \times 20 \text{ kVA} = 200 \text{ kVA}$$

Method-2:

(i) Case-1:





$$I_{CD} = \frac{20 \times 10^3 \text{ VA}}{200 \text{ V}} = 100 \text{ A}$$

$$I_{AB} = \frac{20 \times 10^3 \text{ VA}}{2000 \text{ V}} = 10 \text{ A}$$

S_{auto} = rating of autotransformer

= $(2200) \times I_{CD}$

= 2200×100

= 220 kVA

1.15 (b)

Normally power transformers runs on full load or switched off.

So, it is designed to have maximum efficiency at full load. However for distribution transformer, designing for about 70-75% of full load.

1.16 (a)

Given, $P_{cuFL} = 600 \text{ W} = I_{FL}^2 \cdot R$

$\because$ Copper losses = I^2R losses

i.e., $P_{cu} \; \alpha \; I^2$

At half of full load i.e.,

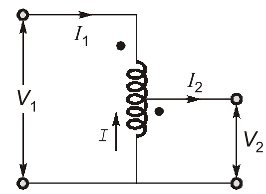
$$I = \frac{I_{FL}}{2}$$

Let, P_{cuHL} = copper loss at half of full load

$$\because \quad \frac{P_{cuFL}}{P_{cuHL}} = \frac{I_{FL}^2 \cdot R}{(I_{FL}/2)^2 \cdot R} = 4$$

$$\Rightarrow \quad P_{cuHL} = \frac{P_{cuFL}}{4} = \frac{600}{4} = 150 \text{ W}$$

1.17 (c)



$$\because \quad \frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{210}{140} = \frac{I_2}{I_1}$$

$$\because \quad I_1 = 60 \text{ A}$$

$$\therefore \quad I_2 = I_1 \times \frac{210}{140} = 60 \times \frac{210}{140} = 90 \text{ A}$$

So, I (common winding current) = 90 – 60 = 30 A

1.18 (a)

Given, V_1 = 200 V

= phase voltage

= line voltage

($\because$ Δ-connection in primary side)

Δ/Y transformer (Given)

Phase turns ratio:

$$\frac{N_2}{N_1} = 6 = \frac{V_2}{V_1}$$

$$\frac{V_2}{200} = 6 \Rightarrow V_2 = 1200 \text{ V}$$

= phase voltage at secondary

Secondary line voltage

$$= \sqrt{3} V_2 = \sqrt{3} \times 1200 = 2078 \text{ V}$$

1.19 (b)

Given, P_i = 1 kW

P_{cufl} = 2 kW

Load for maximum efficiency,

$$(S_\eta)_{max} = S_{\text{full load}} \sqrt{\frac{P_i}{P_{cufl}}}$$

$$= 100 \text{ kVA} \sqrt{\frac{1}{2}} = 70.7 \text{ kVA}$$

1.20 (a)

$\because \quad P_i$ = iron loss = $P_h + P_e$

where, P_h = hysteresis loss $\alpha \; fB_m^2$

Let, $P_h = A \cdot f$ [A → constant]

P_e = eddy current loss $\alpha\ f^2 B_m^2$

Let, $P_e = B \cdot f^2$ [B → constant]

Thus, $P_i = Af + Bf^2$

P_i/f = ironless per unit frequency

$= A + Bf$ ...(i)

Equation (i) represents straight line with positive slope since A and B are positive constants.

1.21 (d)

∵ $P_h = af$ and $P_e = bf^2$

$P_i = P_h + P_e$

Iron loss is given by

$P_i = af + bf^2$

(where a, b are constants > 0)

$$\frac{P_i}{f} = a + bf = 0.001f + 0.01$$

Since, $a = 0.01$ (Given at $f = 0$)

and $b = 0.001$ = slope

where, P_h = Hysteresis loss

$= af = 0.01 \times 100$

(At $f = 100$ Hz.....Given)

or, P_h = 1 watt

Eddy current loss

$= bf^2 = 0.001 \times (100)^2$

= 10 Watts

1.22 (a)

Eddy current losses are due to circulating currents rise in the iron core,

$$P_e \propto f^2 B_m^2 t^2 \text{ per m}^3$$

where, f = frequency

B_m = maximum flux density

t = thickness of laminations

i.e., $P_e \propto f^2$

1.23 (c)

Hysteresis loss, $P_h \propto f B_m^n$

n = Steinmetz coefficient (> 1)

and eddy current loss, $P_e \propto f^2 B_m^2$

Now, $B_m \propto \phi \propto \dfrac{V}{f}$

(Maximum flux density)

$$\therefore \quad P_h \propto f\left(\frac{V}{f}\right)^n$$

or, $P_h \propto V^n . f^{(1-n)}$

and $P_e \propto f^2 \cdot \dfrac{V^2}{f^2}$

i.e., $P_e \propto V^2$

Thus, if V = constant and f is increased then, hysteresis loss will decrease but eddy current loss will remain unchanged.

1.24 (b)

Given, $r_1 = 0.1\ \Omega$, $r_2 = 0.004\ \Omega$

$$a = \frac{1100}{220} = 5$$

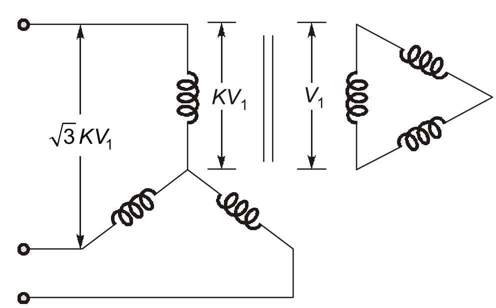
$$(R_{eq})_{HV} = r_1 + a^2 r_2 = 0.1 + (5)^2 \times 0.004 = 0.2\ \Omega$$

and $$(R_{eq})_{LV} = r_2 + \frac{r_1}{a^2} = 0.004 + \frac{0.1}{(5)^2} = 0.008\ \Omega$$

1.25 (c)

Placing HV winding after LV winding is economical as the insualtion requirement gets reduced. In other words, LV winding is kept close to the core and HV winding outside to minimise the amount of insulation required.

1.26 (c)



$$\text{Ratio (phase)} = \frac{KV_1}{V_1} = K = \frac{(V_{ph})_Y}{(V_{ph})_\Delta}$$

$$\text{Now,} \quad \frac{(V_{L-L})_Y}{(V_{L-L})_\Delta} = \frac{\sqrt{3}(V_{ph})_Y}{(V_{ph})_\Delta} = \sqrt{3}K$$

1.27 (d)

Auto-transformation ratio,

$$a_A = \frac{V_1}{V_2} = \frac{V_H}{V_L}$$

Power transferred inductively $\propto \left(1 - \frac{1}{a_A}\right)$

$$\propto \left(1 - \frac{V_2}{V_1}\right)$$

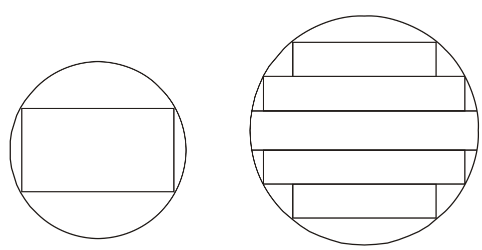
$$\propto \left(\frac{V_1 - V_2}{V_1}\right)$$

Also, conductive transfer $\propto \frac{1}{a_A}$

$$\propto \frac{1}{V_H / V_L} \propto \frac{1}{V_1 / V_2}$$

$$\propto \frac{V_2}{V_1}$$

1.28 (b)



Square core   Stepped core

Stepped core are preferred in order to reduce the length of turn and in the way it reduces the copper wiring requirements. Also it increases efficiency and utilises the space better than any other type of core.

1.29 (d)

Given:

Δ-phase voltage : star phase voltage = a : 1.

Line voltage in Y is

$$(V_L)_Y = \sqrt{3}\, V_{ph}$$

Line voltage in Δ

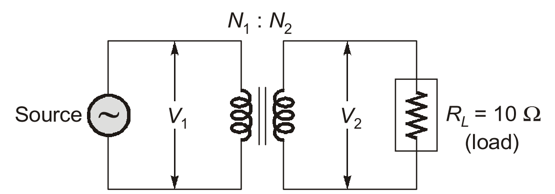
$$(V_L)_\Delta = V_{ph}$$

Now, $\frac{\text{Star phase voltage}}{\text{Delta phase voltage}} = \frac{1}{a}$

Now, $\frac{(V_L)_Y}{(V_L)_\Delta} = \frac{\sqrt{3} \times \text{star phase voltage}}{\text{delta line voltage}}$

$$= \sqrt{3} \times \frac{1}{a} = \frac{\sqrt{3}}{a}$$

1.30 (a)



Given, R_L = 10 Ω (On secondary side)

R_s = 6250 Ω (Primary side)

= source internal resistance

∵ We know, $Z \propto N^2$ ...(i)

Let, turns ratio = $a = \frac{N_1}{N_2}$

When refered to load side:

Using (i), $R_s' = \frac{R_s}{(N_1/N_2)^2}$

$\Rightarrow$ $R_s' = \frac{6250}{a^2}$

For impedance matching,

$$R_s' = R_L$$

i.e., $\frac{6250}{a^2} = 10$

$\Rightarrow$ $a = \sqrt{625} = 25$

1.31 (d)

In shell type transformer, the primary and secondary windings are wounded on one and other to reduce the leakage flux i.e. to reduce leakage reactance.

1.32 (c)

- At no load, the secondary current is zero and the copper loss at no load in transformer can be practically neglected so the total input power drawn will be equal to the iron loss/core loss. No load test or open circuit test is done to find iron loss.
- Since at no load, exciting current is 2-6% of full load current and the ohmic loss or copper loss are negligible in practical transformer.

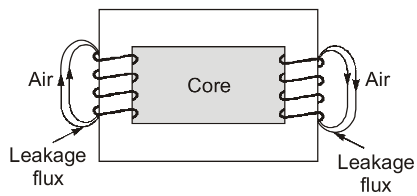
1.33 (d)

- The no load current is negligible as compared to full load current. It is just 3-5% of full load current in transformer.

- However in an induction motor, the no load current is not negligible and constitutes about (30-40%) of the full load rated current.

1.34 (c)

Leakage flux path in transformer is air which is not a good magnetic insulator hence it allows some magnetic flux which is called leakage flux, which links one winding and not the other.



1.35 (b)

For open Δ(delta) or V-V connection, which exists if one transformer of Δ-Δ system is damaged or opened.

Secondary line current = $I_L = I_{ph}$

$$V\text{-}V \text{ capacity} = \sqrt{3}V_L I_L = \sqrt{3}V_L I_{Ph}$$

$$\Delta\text{-}\Delta \text{ capacity} = \sqrt{3}V_L I_L = \sqrt{3}V_L(\sqrt{3}I_{Ph}) = 3V_L I_{Ph}$$

$$\frac{V-V \text{ capacity}}{\Delta-\Delta \text{ capacity}} = \frac{\sqrt{3}V_L I_{Ph}}{3V_L I_{Ph}} = \frac{1}{\sqrt{3}} = 57.7\%$$

1.36 (a)

DC has zero frequency. So there is no change in flux, so no induced voltage in secondary. Further the counter emf E_1 which opposes the applied voltage V_1 is also zero. So primary no load current is limited by primary winding resistance r_1. As r_1 is quite small, so V/r_1 will be very large and primary winding will burn.

1.37 (a)

100% efficiency means no losses, hence for a transformer with 100% efficiency,

$$P_i = P_0$$

i.e., input power is equal to output power.

So, $P_0 = 1000$ W

1.38 (d)

Transformer doesn't have any rotating part, so friction and windage losses are not present in the transformer. Further there is no airgap in transformer whereas airgap is present in motor. To establish the flux in airgap, motor requires more current whereas to establish flux very less current is required by the transformer. It is because of these factors the efficiency of transformer is higher.

1.39 (a)

Given, copper loss at 20% overload i.e. at $I = 1.2\,I_{fl}$, $P_{cu} = 144$ W

$\because \quad P_{cu} \propto I^2$

At full load:

$$P_{fl} = \frac{144}{(1.2)^2} = 100 \text{ W}$$

Iron loss or fixed loss = 64 W = P_i

Load at which efficiency is maximum

$$P_{\eta\max} = \sqrt{\frac{P_i}{P_{cfl}}} \times (\text{Rated kVA})$$

$$P_{\eta\max} = \sqrt{\frac{64}{100}} = 0.8 \times (\text{Rated kVA})$$

i.e., at 80% load, efficiency is maximum.

1.40 (d)

Using emf equation in a transformer,

$$E = \sqrt{2}\pi f N\phi_{max}$$

$$\phi_{max} = \frac{E}{\sqrt{2}\pi f N}$$

i.e., $\quad \phi_{max} \propto \frac{1}{f}$

[For other parameters to be constant]

Also we know,

$$\phi_m = B.A$$

i.e., lower the value of ϕ_{max}, lower will be the area (or size) of the transformer hence for $f = 600$ Hz (maximum), ϕ_m is least value and thus at this frequency, smallest size transformer will be there.

1.41 (b)

Let, S_L : Total load

S_A : Load shared by transformer A

S_B : Load shared by transformer B

Z_B, Z_A : Ohmic impedances of B and A transformers respectively

Then, $\quad S_A = \frac{Z_B}{Z_A + Z_B} \cdot S_L$

$$S_B = \frac{Z_A}{Z_A + Z_B} \cdot S_L$$

The transformers in parallel to share the total load in proportion to their kVA ratings, then their equivalent leakage impedances (Z_A and Z_B) in ohms must be inverse of proportional to their kVA ratings.

1.42 (b)

- Short-circuit test is carried out on a transformer to determine the copper loss or ohmic loss.
- Instruments kept on HV side and LV side short circuited.
- This test also determine the equivalent resistance and equivalent leakage reactance.

1.43 (c)

At high load copper losses increases as $P_c \propto I^2$

$I \rightarrow$ Load current

Due to increase in copper losses, efficiency decreases.

1.44 (d)

Given, 20 : 1 is turns ratio

i.e. $$\frac{N_p}{N_s} = \frac{20}{1} = \frac{100}{5} = \frac{40}{2} = ... \text{ so on}$$

Thus clearly, we can see that if does not means that there are only 20 turns on primary side and 1 turn on secondary side. It's the ratio of turns i.e. for every 20 turns on primary, there will be one turn on secondary side.

$\because$ Also we know,

$$\frac{V_p}{V_s} = \frac{N_s}{N_p} = \frac{1}{20}$$

$\Rightarrow$ $V_s = 20\ V_p$

Hence (b) is not correct.

Also, $I_pN_p = I_sN_s$

$\Rightarrow$ $$I_p = \frac{1}{20} \cdot I_s$$

Hence, (c) is not correct.

1.45. (d)

$\because$ $$\text{Reluctance} = \frac{L}{\mu A}$$

μ = permeability

The core is of high permeability material which has low reluctance to flux. Flux can easily confined to the core. Core allow the magnetic flux with lowest reluctance.

In iron-core transformers, most of the flux is confined to high permeability core.

1.46 (a)

Current transformer (C.T.) is an instrument transformer whose primary winding connected in series with the line carrying the load while secondary winding is connected to burden (ammeter, relay etc). It is for measurement of large magnitude of current.

This is 100/5 A C.T.

$\because$ $$\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{I_p}{I_s} = \frac{100}{5} = 20$$

$\Rightarrow$ $V_2 > V_1$ i.e. step up transformer

Note: Step up and step down is related to the votlage level.

1.47 (d)

- Transformer failures occurs due to contaminated and deteriorated oil so it's important to filter the oil and regular maintenance is necessary.
- Slow centrifuges can be used for removal of dirt and solid impurities. Power driven centrifuges can remove water from oil. It can also be used for removal of dissolved gases.

1.48 (a)

Step up transformer is a transformer that increaes the voltage level from primary to secondary having more secondary turns than primary side.

i.e., $N_s > N_p$ (for step up transformer)

$\because$ $$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

Thus, $V_s > V_p$ and $I_p > I_s$

i.e. primary has lower voltage and higher current than secondary.

1.49 (c)

If secondary is open circuited, when primary is carrying current, the primary winding mmf is same but secondary mmf is zero. $F_P = I_P N_P$ is very large as no demagnetizing mmf.

It produces a large flux in core till it saturates. This would also induce a high voltage in the secondary. Which could be dangerous, so it is kept short circuited under normal conditions when primary is energized.

1.50 (b)

Iron loss ∝ (Voltage)^2

In short-circuit test voltage required to flow rated current is 2% to 12%. About half (1% to 6%) will appear across exciting branch. Also the core flux is (1 – 6%) of its rated value. Hence core loss will be negligible in short-circuit test.

1.51 (a)

$$f_1 = 400 \text{ Hz}, \; f_2 = 50 \text{ Hz}$$

Induced voltage,

$$V = \sqrt{2}\pi f \, BAN$$

$$f \rightarrow \text{frequency}$$

$$V \propto f$$

$$\text{kVA rating} = V \cdot I$$

$$(\text{kVA})_I = V_1 \cdot I$$

$$(\text{kVA})_{II} = V_2 \cdot I$$

i.e. $\quad \text{kVA} \propto f$

$$\Rightarrow \quad \frac{(\text{kVA})_{II}}{(\text{kVA})_I} = \frac{50}{400} = \frac{1}{8}$$

$$(\text{kVA})_{II} = \frac{1}{8}(\text{kVA})_I$$

1.52 (c)

Efficiency is maximum when fixed losses = variable losses.

i.e., Fixed loss = Iron losses

Variable losses = Copper losses

Hence, for maximum efficiency,

Iron losses = Copper losses

1.53 (b)

In short-circuit test on a transformer, LV (low voltage) side is short circuited and the instruments are placed on the high voltage side. For a short-circuit test, having the instruments on HV side, instrument ranges are well within the range of the ordinary instruments and will give more accurate results.

1.54 (a)

Here polarity can be either additive or subtractive.

(i) For positive polarity:

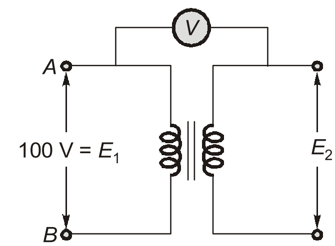
Given, $E_1 = 100$ V

$E_1 + E_2 = 100$ V (Voltmeter reading)

$\Rightarrow \quad E_2 = 100 \text{ V} - E_1$

$= 100 \text{ V} - 100 \text{ V}$

$= 0$ (Not possible)



(ii) For subtractive polarity:

Case-1:

$E_1 - E_2 = 100$

$\Rightarrow \quad E_2 = 0$ V (Not possible)

Case-2:

$E_2 - E_1 = 100$

$E_2 = E_1 + 100$

$= 200$ V (Possible)

i.e. turns ratio

$$= \frac{N_1}{N_2} = \frac{E_1}{E_2} = \frac{100}{200} = \frac{1}{2}$$

i.e. $N_1 : N_2 = 1 : 2$

1.55 (c)

- Tappings are provided on the HV winding to get a fine variation of voltage owing to large number of turns.
- Tappings can also be provided at phase ends or in the middle of the windings.
- The advantages of providing tappings at phase ends is that the number of bushing insulators are reduced, this is important when cover space is limited.

1.56 (b)

For maximum efficiency copper losses = Iron losses

Let $n \rightarrow$ fraction of load at which maximum efficiency occurs

i.e. $\quad n^2 P_C = P_i$

where,

$P_C \rightarrow$ Full load copper loss

$P_i \rightarrow$ Iron loss

$$n^2 \times 2 \times 10^3 = 1 \times 10^3$$

$$n^2 = \frac{1}{2}$$

$$n = \frac{1}{\sqrt{2}} = 0.707$$

$$\text{Load} = n \times \text{Rated kVA}$$

So, $\text{Load} = (n)(100 \times 10^3)$

$$= 70.7 \text{ kVA}$$

1.57 (d)

Distribution transformer remains energised at all loading conditions. So distribution transformer will supply iron losses all along the day. For the distribution transformer to have high efficiency it should be designed to have very low value of core losses or iron losses.

But as the question asked for high efficiency, then it would be obvious if both core losses and copper losses will below. It's not mentioned like how a distribution transformer should be designed. Thus (d) is better choice than (b).

$$\because \eta_{\text{all day}} = \frac{\text{Output kWh in 24 hrs}}{\text{Input kWh in 24 hrs}}$$

$$= \frac{\text{Output kWh in 24 hrs}}{\text{Output kWh in 24 hrs + kWh iron loss in 24 hrs + kW copper loss in 24 hrs}}$$

1.58 (d)

Due to the oxidation the acid forms in the oil when its reacts with oxygen. The acid will form sludge which will settle on the windings of the transformer reducing the heat dissipation from the transformer.

1.59 (a)

Maximum efficiency occurs at, the load:

$$\text{Load kVA} = \sqrt{\frac{P_i}{P_c}} \cdot \text{Rated kVA}$$

P_i = Iron losses = 500 W

P_c = 2000 W = FL copper losses

i.e. $\text{load kVA} = \sqrt{\frac{500}{2000}} = 500 \text{ kVA}$

$\Rightarrow$ Load kVA = (500) (0.5) = 250 kVA

1.60 (d)

All day efficiency depends upon the load curve of the transformer which includes amount and duration of load.

All day efficiency $= \eta_{\text{all day}}$

$$= \frac{\text{Output kWh in 24 hrs}}{\text{Input kWh in 24 hrs}}$$

$$\eta_{\text{all day}} = \frac{\text{Output kWh in 24 hrs}}{\text{Output kWh in 24 hrs + kWh iron loss in 24 hrs + kWh copper loss in 24 hrs}}$$

i.e. both amount and time period is included in $\eta_{\text{all day}}$.

1.61 (b)

In transformer, silica gel breather is to absorb the moisture in the air sucked by the transformer in case of reduction in load. When load is increased, volume of oil is increased and air above the oil level in conservator will expelled outside.

1.62 (a)

For lagging p.f.,

% voltage regulation is given as

$$\%VR = (\in_r \cos\theta_r + \in_x \sin\theta_r) \times 100$$

where,

$$\in_r = \frac{I_2^2 r_2}{VI_2} = \frac{I_2 r_2}{V} = 0.01$$

= p.u. resistance drop

$$\in_x = \frac{I_2 x_2}{V} = 0.05$$

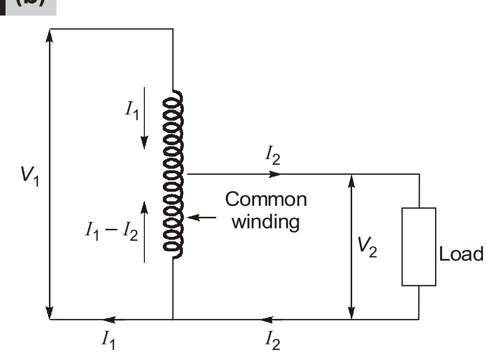
= p.u. reactance drop

$\cos\theta_r = 0.9$, $\sin\theta_r = 0.436$

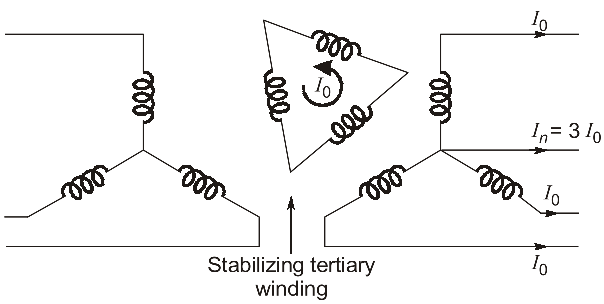
$$\%VR = [(0.01)(0.9) + (0.05)(0.436)] \times 100$$

$$\%VR = 3.08\%$$

1.63 (b)



1.64 (b)



1.65 (c)

$$P_n \propto B_m^{1.6}$$
$$P_n \propto f$$
$$P_n \propto V$$

Hence $\quad P_n = \eta\, B_m^{1.6}\, f\, V$

1.66 (c)

Stepped cores resists the flow of eddy currents in the core, thus preventing the core from iron losses.

1.67 (d)

In a transformer, primary is electrically isolated with secondary. Hence, infinite resistance between primary and secondary power transfer in transformer takes place magnetically.

1.68 (b)

Voltage regulation of a transformer is given approximately as

$$V_0R_0 = R\cos\phi + X\sin\phi \text{ (for lag load)}$$
$$V_0R_0 = R\cos\phi - X\sin\phi \text{ (for lead load)}$$

Hence, $R\cos\phi = X\sin\phi$

$$\tan\phi = \frac{R}{X}$$

$$\phi = \tan^{-1}\frac{R}{X}$$

At this angle of lead load, zero regulation happens.

1.69 (d)

Tapings are provided on HV side so current is minimum during transition of one tap to another and hence less spark. Tapings are provided at middle to provide maximum control of voltage through laps.

1.70 (b)

In 2 winding transformer, energy transfer is only through induction. Whereas in auto transformer, it is through conduction also.

1.71 (a)

Voltage regulation is defined as

$$V_0R_0 = \frac{V_{\text{no load}} - V_{\text{rated}}}{V_{\text{rated}}} = \frac{E-V}{V}$$

1.72 (c)

In an auto-transformer, primary and secondary are electrically connected, power transfer takes place through both induction and conduction.

1.73 (d)

Core is made from laminated sheath to prevent eddy and hysteresis losses.

1.74 (b)

$$P_e = K_e B_m^2 t^2 f^2 \text{ V}$$

Given
$$K_e = 1$$
$$B_m = 4 \text{ T}$$
$$t = 0.04 \text{ m}$$
$$f = 50 \text{ Hz}$$
$$V = 2 \text{ m}^3$$
$$P_e = 1 \times (4)^2 \times (0.04)^2 \times (50)^2 \times 2$$
$$= 128 \text{ W}$$

1.75 (b)

$$\frac{S_{\text{conductive}}}{S_{\text{total}}} = a_{\text{auto}}$$
$$S_{\text{conductive}} = a_{\text{auto}} \times S_{\text{total}}$$

Given,
$$a_{\text{auto}} = 0.4$$
$$S_{\text{total}} = 10 \text{ kVA}$$
$$S_{\text{conductive}} = 4 \text{ kVA}$$
$$S_{\text{inductive}} = S_{\text{total}} - S_{\text{conductive}}$$
$$= 10 - 4 = 6 \text{ kVA}$$

1.76 (b)

For parallel operation, transformer's percentage impedance should be same for proportional load sharing.

1.77 (c)

A Scott or T connection is used to convert 3ϕ supply to 2 phase supply with phase difference of 90°.

1.78 (c)

Auto transformer transfers power by both induction and conduction.

1.79 (c)

Maximum efficiency occurs when copper loss equals from loss

$$P_i = P_w$$

$$\Rightarrow \quad P_w = 450 \text{ W}$$

1.80 (d)

$$P_e = K_e B_m^2 f^2 t V$$

Given, $P_e = 600$ W

$K_e = 2$

$f = 50$ Hz

$t = 4 \times 10^{-3}$ m

Volume $= 20$ m^3

$$600 = 2 \times B_m^2 \times (50)^2 \times 4 \times 10^{-3} \times 20$$

$$B_m^2 = \frac{600}{2 \times (50)^2 \times 4 \times 10^{-3} \times 20}$$

$$B_m^2 = 1.5$$

$$B_m = 1.21 \text{ T}$$

1.81 (a)

Eddy current loss is given by

$$P_e = K_e f^2 B_m^2 t^2 V$$

where, K = Constant

f = Frequency

B_m = Maximum magnetic flux density

t = Thickness of material

V = Volume

1.82 (d)

Load sharing by the transformer is inversely proportional with their impedance.

$$S \propto \frac{1}{Z}$$

1.83 (b)

The transformer works on the principle of electromagnetic induction law given by Faraday's.

1.84 (b)

The transformer, heat is produced in the windings due to flow of electric current and also due to core losses and heat is circulated inside the transformer by convectional circulation.

1.85 (d)

A transformer is a static device for transferring electrical energy. It step-ups or step-downs the voltage. It works on principle of electromagnetic induction, so step-up or down AC voltage and current.

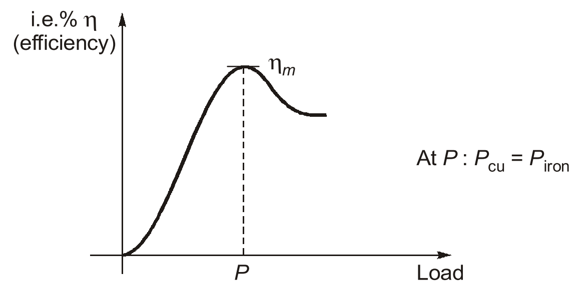
1.86 (a)

Power factor of on load transformer depends on the power factor of load. If its resistive, pf is unity, if its inductive load, pf is lag.

1.87 (d)

Condition for maximum efficiency:

Variable ohmic loss = Fixed core losses



1.88 (b)

$$\because \text{ Leakage factor } (\lambda) = \frac{\text{Flux in iron path}}{\text{Flux in air gap}}$$

Hence, $\lambda = \dfrac{\phi_a}{\phi_g}$

1.89 (a)

Breather absorbs moisture from air entering the conservator tank using silica gel which when absorbs moisture changes its colour from blue to pink.

This happens to prevent oil from direct exposure to atmosphere to avoid its deterioration.

1.90 (b)

In a two winding transformer, primary and secondary windings are magnetically coupled, yet electrically isolated from each other. It works on the principle of electromagnetic induction.

1.91 (a)

Commutator is a part of DC machine which convert alternating current in the armature into direct current.

1.92 (a)

Short circuit test gives the following information.

a. Copper loss at rated current and frequency.
b. Equivalent resistance and equivalent leakage reactance.

1.93 (b)

A transformer is a static device used to change the voltage and step up transformer increases the voltage.

1.94 (d)

Hysteresis loss occurring in a material does not depend on reluctivity.

Hysteresis loss = $K_h \times B_m^{1.6} \times f \times V$ watts

where,

K_h - Hysteresis constant depends upon the material.

B_m - Maximum flux density

f - Frequency

V - Volume of core

1.95 (c)

Eddy current coefficient, $K_e = 1$

Thickness, $t = 0.02$ m

Volume, $V = 1\ m^3$

Maximum flux density, $B_m = 2T$

Frequency, $f = 50$ H

$\therefore$ Eddy current loss = $K_e \times B_m^2 \times f^2 \times V \times t^2$

$= (1)\,(2)^2 (50)^2 (1)\,(0.02)^2 = 4$ W

1.96 (b)

The no-load current in a transformer is non-sinusoidal.

1.97 (a)

Transformer oil should possess the following properties:

- Low viscosity to provide good heat transfer.
- High dielectric strength
- Low volatility for low vaporization of oil.
- Good resistance to the emulsion.
- Free from inorganic acid, alkali and corrosive sulfur.
- High flash/fire point.

1.98 (a)

For 1 - ϕ transformer to operate parallel, their voltages rating must be equal to reduce the permissible output of the parallel combined group because circulating current produces unequal load sharing. They increase power loss.

1.99 (c)

Eddy current loss, $w_e = k_e f^2 k_f^2 B_m^2$ Watt/m^3

where, B_m = Magnetic flux density

f - Frequency

and above eddy current loss is per unit volume. Hence, it is not depends on susceptibility.

1.100 (d)

Given,

k_e - Eddy current coefficient = 1

t - Material thickness = 0.03 m

V - Volume of material = 2 m^3

B_m - Maximum magnetic field = $3T$

f - Supply frequency = 50 Hz

$\therefore$ Eddy current loss, $P_e = k_e f^2 B_m^2 t^2 \times V$

$= (1)\,(50)^2 (3)^2 (0.03)^2 (2)$

$= 40.5$ watt

1.101 (c)

Transformer oil serves two purposes:

(i) Insulation (ii) As a coolant

1.102 (a)

Short circuit test is carried out with the instrument placed on the HV side while the low voltage side is short circuited by a thick conductor.

1.103 (b)

$$\text{Transformation ratio} = \frac{\text{Secondary Voltage}}{\text{Primary Voltage}}$$

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

1.104 (c)

Isolation transformer has a 1:1 turn's ratio

1.105. (a)

In a square wave the changes in amplitude, takes place only at the side edge of waveform hence transformation action takes place only at these edges because of this output voltage will be of pulsed wave.

1.106 (c)

Total core loss or magnetic loss or iron loss.

1.107 (b)

According to Lenz law, induced emf will be equal and opposite to the applied voltage.

1.108 (a)

In core type transformer, the low voltage winding is done near the core in order to reduce the cost of insulation and the size of transformer.

1.109 (a)

In design of transformer, higher flux density is used, due to which weight per KVA decreases.

$\because \phi = BA$

$$\uparrow B = \frac{\phi}{A\downarrow}$$

So, high value of flux density gives smaller core area, so saving of iron cost, also small core area provides reduced mean turn of the winding which gives reduction in copper cost. So, size of transformer decreases, as B is high for same flux.

1.110 (d)

Flux in transformer, $\phi \propto \frac{V}{f}$. Hence it mainly depends on voltage and frequency.

1.111 (c)

Insulating oil in an electrical power transformer is commonly known as transformer oil. This oil is also known as mineral insulating oil.

1.112 (c)

Welding transformer are used in AC machines to change the alternating current from the power line into a low voltage high current in the secondary winding.

1.113 (d)

In case of transformers, maximum efficiency occurs at the condition:

Copper loss or variable loss = Iron loss

Thus total loss at the condition of maximum efficiency will be

$$P_{\text{total loss}} = 2 \times P_{\text{iron}} \text{ loss}$$
$$= 2 \times 150 = 300 \text{ W}$$

1.114 (d)

Given, at half full load, copper loss = P_{cuHL} = 400 W.

$\because \quad P_{cu} \propto (I)^2 \propto (\text{kVA})^2$

Thus, $$\frac{P_{cuFL}}{P_{cuHL}} = \frac{(I_{FL})^2}{\left(\frac{I_{FL}}{2}\right)^2}$$

i.e. $\quad P_{cuFL} = P_{cuHL} \times 4$

$\Rightarrow \quad P_{cuFL} = 400 \times 4 = 1600 \text{ W}$

1.115 (c)

Core loss and iron loss are the same thing. The core loss occuring in the machine consists of two components, hysteresis loss (P_h) and eddy current loss (P_c).

i.e., $\quad P_{iron} = P_h + P_e$

1.116 (a)

For $N_1 : N_2 = 1 : 1$, i.e. turns ratio to be one, transformer is said to be an isolation transformer and no change in voltage or current level takes place i.e. No HV side or LV side. Such transformers will be solely responsible only for isolation purpose of two circuits on either side of the transformer.

1.117 (d)

Hysteresis loss occur in core due to continuous magnetic reversals and power required for their reversals. It is given by expressions,

$$P_h = K_h \cdot f B_m^x$$

where,

K_h be material constant, f is frequency.

B_m is maximum flux density, x = steinmetz's constant.

P_h = hysteresis loss per unit volume.

1.118 (a)

- A transformer is a static device which transfer electrical energy from one circuit to other without change in the frequency. It is basically employed to change voltage or current level in power systems.
- Also, an ideal transformer will have zero losses and hence power at input side will be same as that of output side.

2. DC Machines

2.1 (d)

- Speed regulation is the ratio of speed change from no load to full load to the rated (or base) speed. On application of load, speed of a dc motor decreases which is not desirable.
- Lower the difference of speed between no load and full load speed, better will be the speed regulation.
- Speed regulation of DC shunt motor is good <10%. For cumulative compound dc motor, it is around 20-25%, while differential compound motor have about 5%. DC series motor has poorest value of regulation and it gives infinite speed at no load condition.

2.2 (a)

For DC motors:

Torque, $T = k\phi I_a$

where, $\phi \rightarrow$ flux and $I_a \rightarrow$ current

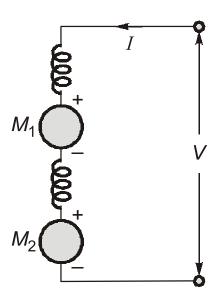
For series motor $\phi \propto I_a$

$\therefore \quad T = k \cdot I_a \cdot I_a$

or $\quad T \propto I_a^2$

For series connection:

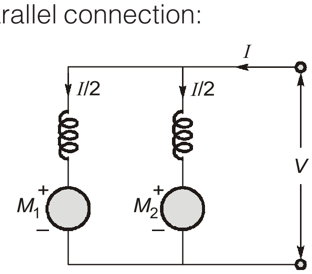
Input power $= V \cdot I$



$T_A = T_B = k\phi \cdot I = T$

or $\quad T = kI^2 \quad \quad ...(i)$

For parallel connection:



Each motor will have the half value of current now (if the drawn power is constant).

$\therefore \quad T_{\text{parallel}} \propto \phi \cdot \frac{I}{2}$ (for each motor)

or $\quad T_{\text{parallel}} \propto \frac{I}{2} \cdot \frac{I}{2}$ (as $\phi \propto I$)

or, $\quad T_{\text{parallel}} = \frac{kI^2}{4} \quad \quad ...(ii)$

From equation (i) and (ii),

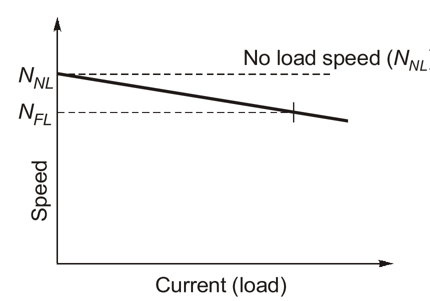
$$T_{\text{parallel}} = \frac{T}{4}$$

2.3 (a)

Cranes and hoists require high starting torque. For the higher starting torque requirements dc series motors or 3-ϕ induction motors are used. Particularly for traction (Railway) applications dc series motor is used. Here, the option (a) is correct.

2.4 (a)

- DC shunt motor has the best speed regulation i.e. for the variation in load the speed change is minimum. Hence, we can have a wide range of speed in the shunt motor applications.
- When driven load requires a wide range of control of speed (both above and below base speed), a DC shunt motor is employed, e.g. in lathes.



Speed regulation $= \dfrac{N_{NL} - N_{FL}}{N_{FL}}$

This speed regulation is low in case of shunt motor.

2.5 (b)

Applications of shunt wound DC generator:

(i) in general lighting

(ii) they are used to charge battery because they can be made to give constant output voltage

(iii) exciters for alternators

DC shunt generators generally give constant terminal voltage with help of field regulators from no load to full load.

2.6 (c)

At no load, $I_a = 0$

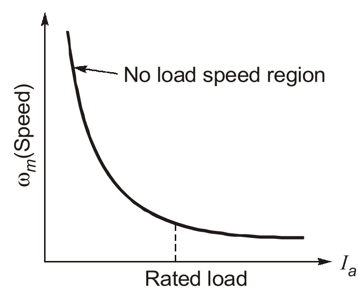
$\because$ Back emf,

$$E_b = V - I_aR_a = K\phi\omega_n$$

$$\Rightarrow \quad \omega_m \propto \frac{V - I_aR_s}{\phi}$$

For $I_a = 0$, $\phi = 0 \Rightarrow \omega_m$ is very high and it's dangerous to start series motor at no load.

The load-speed curve of DC series motor is shown below.



It is clear that the speed of the DC series motor at no load is very high. So, it is never started at no load.

2.7 (d)

Interpoles are used to reduce the effect of armature reaction in interpolar region and also to nullify the effect of induced emf, generated in the coil undergoing commutation. Due to this emf, the sparking occurs and interpoles help in reducing the sparking occurring at the commutator.

2.8 (b)

The emf generated,

$$E = \frac{P\phi NZ}{60\,A}$$

Given,

$P = 4$, $\phi = 0.01$ Weber

$A = P = 4$ (for lap)

$N = 1200$ rpm, $Z = 1520$

$\therefore$ Emf, $$E = \frac{4 \times 0.01 \times 1200 \times 1520}{60 \times 4}$$

$$E = 304 \text{ Volts}$$

2.9 (b)

Consider separately excited dc motor,

$$P_{out} = E_bI_a$$

$$= (V - I_aR_a)\,I_a$$

$$= VI_a - I_a^2R_a$$

For maximum power out from dc motor,

$$\frac{dP_{out}}{dI_a} = 0$$

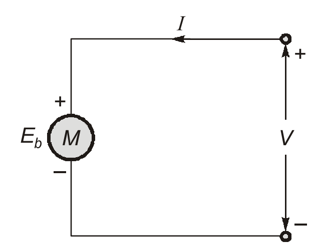
$$\Rightarrow \quad V - 2I_aR_a = 0$$

$$I_a = \frac{V}{2R_a}$$

$$\because \quad E_b = V - I_aR_a$$

$$= V - \frac{V}{2} = \frac{V}{2}$$

$$\Rightarrow \quad E_b = \frac{V}{2} \text{ is required condition}$$



Similarly for generator $V = E/2$ is condition for maximum power in DC generator.

2.10 (d)

Swinburne's method is a no load test on dc machine. It cannot be performed on a dc series motor. In this testing method, the machine whether it's a motor or a generator is run as no-load shunt motor at rated speed and rated terminal voltage.

2.11 (c)

In a DC machine, carbon brushes are kept along MNA (Magnetic Neutral Axis). Physically, brushes of a DC machine should be placed on the commutator in the polar axis. In order to reduce the effect of armature reaction, carbon brushes are given shift.

2.12 (d)