SSC-JE

Staff Selection Commission

Junior Engineer

Electrical Engineering

Topicwise Objective Solved Questions

Volume-II

Previous Years Solved Papers : 2007-2024

Also useful for ***RRB-JE Mains*** *as well as various* **public sector examinations** and other competitive examinations

MADE EASY PUBLICATIONS

www.madeeasypublications.org

MADE EASY Publications Pvt. Ltd.

Corporate Office: 44-A/4, Kalu Sarai (Near Hauz Khas Metro Station), New Delhi-110016
E-mail: infomep@madeeasy.in
Contact: 9021300500
Visit us at: www.madeeasypublications.org

SSC-JE : Paper-I
Electrical Engineering Previous Years Solved Papers : Volume-II

First Edition: 2016

Second Edition: 2018

Third Edition: 2019

Fourth Edition: 2020

Fifth Edition: 2021

Reprint: 2022

Sixth Edition : 2023

Seventh Edition : 2024

Eighth Edition: 2024 (Sept.)

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 : Electrical	50 Marks 50 Marks 100 Marks	2 hours
Stage 2: Paper-II : Objective Type	General Engineering : Electrical	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.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

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.

■■■■

SSC-JE : Paper-I

Contents

Electrical Engineering : Volume-II
Previous Years Objective Solved Papers

■■■■

CHAPTER 1

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) 1/4th of full load
(d) 3/4th 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]

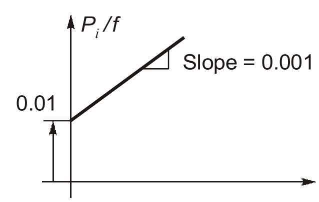
1.17 In autotransformer, the number of turns in primary winding is 210 and in secondary winding is 140. If the input current is 60 A, the currents in output and in common winding are respectively
(a) 40 A, 20 A (b) 40 A, 100 A
(c) 90 A, 30 A (d) 90 A, 150 A
[SSC-JE : 2012]

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]

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)	1.119	(b)	1.120	(b)
1.121	(b)	1.122	(b)	1.123	(b)	1.124	(b)	1.125	(b)	1.126	(a)	1.127	(a)	1.128	(a)
1.129.	(b)	1.130	(c)	1.131	(b)	1.132	(d)	1.133	(d)	1.134	(b)	1.135	(c)	1.136	(b)
1.137	(c)	1.138	(b)	1.139	(b)	1.140	(b)	1.141	(d)	1.142	(c)	1.143	(a)	1.144	(a)
1.145	(b)	1.146	(c)	1.147	(b)	1.148	(a)	1.149	(d)	1.150	(b)	1.151	(a)	1.152	(d)
1.153	(d)	1.154	(a)	1.155	(d)	1.156	(d)	1.157	(d)	1.158	(b)	1.159	(b)	1.160	(c)
1.161	(b)	1.162	(a)	1.163	(c)	1.164	(d)	1.165	(c)	1.166	(c)	1.167	(b)	1.168	(d)
1.169	(b)	1.170	(c)	1.171	(c)	1.172	(d)	1.173	(a)	1.174	(c)	1.175	(d)	1.176	(d)
1.177	(c)	1.178	(d)	1.179	(c)	1.180	(c)								

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	(a)	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)
2.129	(b)	2.130	(a)	2.131	(c)	2.132	(b)	2.133	(b)	2.134	(a)	2.135	(c)	2.136	(b)
2.137	(d)	2.138	(b)	2.139	(c)	2.140	(a)	2.141	(a)	2.142	(a)	2.143	(b)	2.144	(a)
2.145	(d)	2.146	(c)	2.147	(b)	2.148	(c)	2.149	(d)	2.150	(d)	2.151	(b)	2.152	(d)
2.153	(b)	2.154	(a)	2.155	(a)	2.156	(d)	2.157	(c)	2.158	(a)	2.159	(d)	2.160	(a)
2.161	(b)	2.162	(b)	2.163	(b)	2.164	(b)	2.165	(a)	2.166	(a)	2.167	(a)	2.168	(d)
2.169	(b)	2.170	(d)	2.171	(c)	2.172	(d)	2.173	(a)	2.174	(c)	2.175	(b)	2.176	(a)
2.177	(a)	2.178	(b)	2.179	(d)	2.180	(d)	2.181	(d)	2.182	(b)	2.183	(d)	2.184	(b)
2.185	(b)	2.186	(c)	2.187	(d)	2.188	(c)	2.189	(a)	2.190	(c)	2.191	(a)	2.192	(c)
2.193	(c)	2.194	(c)	2.195	(b)	2.196	(a)	2.197	(c)	2.198	(b)	2.199	(b)	2.200	(c)
2.201	(a)	2.202	(a)	2.203	(b)	2.204	(b)	2.205	(c)	2.206	(b)	2.207	(b)	2.208	(a)
2.209	(a)	2.210	(a)	2.211	(b)	2.212	(a)	2.213	(d)	2.214	(d)	2.215	(d)	2.216	(b)
2.217	(b)	2.218	(a)	2.219	(a)	2.220	(c)	2.221	(d)	2.222	(c)	2.223	(d)	2.224	(d)
2.225	(b)	2.226	(b)	2.227	(d)	2.228	(b)								

3. Three Phase Induction Machines

3.1	(a)	3.2	(c)	3.3	(b)	3.4	(c)	3.5	(c)	3.6	(d)	3.7	(c)	3.8	(a)
3.9	(a)	3.10	(b)	3.11	(b)	3.12	(b)	3.13	(c)	3.14	(b)	3.15	(d)	3.16	(a)
3.17	(b)	3.18	(b)	3.19	(c)	3.20	(c)	3.21	(d)	3.22	(d)	3.23	(b)	3.24	(a)
3.25	(d)	3.26	(d)	3.27	(c)	3.28	(c)	3.29	(c)	3.30	(c)	3.31	(d)	3.32	(c)
3.33	(d)	3.34	(d)	3.35	(c)	3.36	(b)	3.37	(c)	3.38	(b)	3.39	(b)	3.40	(b)
3.41	(c)	3.42	(d)	3.43	(a)	3.44	(d)	3.45	(c)	3.46	(d)	3.47	(d)	3.48	(c)
3.49	(c)	3.50	(b)	3.51	(a)	3.52	(c)	3.53	(d)	3.54	(a)	3.55	(d)	3.56	(a)
3.57	(c)	3.58	(b)	3.59	(a)	3.60	(a)	3.61	(a)	3.62	(a)	3.63	(c)	3.64	(b)
3.65	(b)	3.66	(b)	3.67	(b)	3.68	(a)	3.69	(b)	3.70	(c)	3.71	(c)	3.72	(c)
3.73	(b)	3.74	(b)	3.75	(c)	3.76	(c)	3.77	(a)	3.78	(a)	3.79	(a)	3.80	(b)
3.81	(d)	3.82	(c)	3.83	(b)	3.84	(c)	3.85	(a)	3.86	(d)	3.87	(c)	3.88	(d)
3.89	(b)	3.90	(d)	3.91	(c)	3.92	(a)	3.93	(b)	3.94	(d)	3.95	(b)	3.96	(b)
3.97	(d)	3.98	(a)	3.99	(a)	3.100	(b)	3.101	(a)	3.102	(d)	3.103	(d)	3.104	(a)
3.105	(b)	3.106	(d)	3.107	(a)	3.108	(d)	3.109	(a)	3.110	(b)	3.111	(c)	3.112	(a)
3.113	(b)	3.114	(b)	3.115	(c)	3.116	(b)	3.117	(c)	3.118	(b)	3.119	(c)	3.120	(d)
3.121	(a)	3.122	(c)	3.123	(d)	3.124	(b)	3.125	(c)	3.126	(d)	3.127	(c)	3.128	(a)
3.129	(d)	3.130	(b)	3.131	(b)	3.132	(a)								

4. Synchronous Machines

4.1	(b)	4.2	(c)	4.3	(a)	4.4	(d)	4.5	(d)	4.6	(d)	4.7	(b)	4.8	(a)
4.9	(c)	4.10	(b)	4.11	(b)	4.12	(c)	4.13	(d)	4.14	(d)	4.15	(c)	4.16	(d)
4.17	(d)	4.18	(b)	4.19	(d)	4.20	(d)	4.21	(b)	4.22	(c)	4.23	(d)	4.24	(b)
4.25	(a)	4.26	(b)	4.27	(b)	4.28	(a)	4.29	(c)	4.30	(c)	4.31	(a)	4.32	(c)
4.33	(a)	4.34	(d)	4.35	(a)	4.36	(a)	4.37	(c)	4.38	(c)	4.39	(c)	4.40	(b)
4.41	(b)	4.42	(c)	4.43	(a)	4.44	(a)	4.45	(d)	4.46	(a)	4.47	(d)	4.48	(a)
4.49	(c)	4.50	(a)	4.51	(b)	4.52	(a)	4.53	(c)	4.54	(a)	4.55	(a)	4.56	(a)
4.57	(a)	4.58	(b)	4.59	(b)	4.60	(a)	4.61	(b)	4.62	(b)	4.63	(b)	4.64	(d)
4.65	(a)	4.66	(c)	4.67	(d)	4.68	(c)	4.69	(c)	4.70	(d)	4.71	(b)	4.72	(c)
4.73	(b)	4.74	(a)	4.75	(b)	4.76	(b)	4.77	(a)	4.78	(a)	4.79	(c)	4.80	(a)
4.81	(c)	4.82	(b)	4.83	(b)	4.84	(b)	4.85	(c)	4.86	(b)	4.87	(a)	4.88	(d)
4.89	(d)	4.90	(d)	4.91	(b)	4.92	(b)	4.93	(d)	4.94	(c)	4.95	(b)	4.96	(b)
4.97	(c)	4.98	(d)	4.99	(a)	4.100	(c)	4.101	(a)	4.102	(b)	4.103	(b)	4.104	(b)
4.105	(b)	4.106	(a)	4.107	(b)	4.108	(d)	4.109	(c)	4.110	(b)	4.111	(a)	4.112	(b)
4.113	(c)	4.114	(b)	4.115	(b)	4.116	(c)	4.117	(b)	4.118	(a)	4.119	(d)	4.120	(b)
4.121	(b)	4.122	(c)	4.123	(c)	4.124	(d)	4.125	(d)	4.126	(c)	4.127	(a)	4.128	(b)
4.129	(c)	4.130	(c)	4.131	(d)	4.132	(a)	4.133	(a)	4.134	(b)	4.135	(a)	4.136	(c)
4.137	(a)	4.138	(d)	4.139	(c)	4.140	(b)	4.141	(b)	4.142	(b)	4.143	(c)	4.144	(d)
4.145	(d)	4.146	(d)	4.147	(c)	4.148	(b)	4.149	(a)	4.150	(d)	4.151	(c)	4.152	(b)
4.153	(d)	4.154	(c)	4.155	(a)	4.156	(a)	4.157	(b)	4.158	(d)	4.159	(a)	4.160	(a)
4.161	(c)	4.162	(b)	4.163	(a)	4.164	(a)	4.165	(c)	4.166	(a)	4.167	(b)	4.168	(b)
4.169	(d)	4.170	(a)	4.171	(c)	4.172	(d)	4.173	(d)	4.174	(b)	4.175	(a)	4.176	(d)
4.177	(c)	4.178	(b)	4.179	(d)	4.180	(c)	4.181.	(d)	4.182	(b)	4.183	(d)	4.184	(a)
4.185	(d)	4.186	(c)	4.187	(a)	4.188	(a)	4.189	(d)	4.190	(d)	4.191	(a)	4.192	(b)
4.193	(a)	4.194	(d)	4.195	(b)	4.196	(b)	4.197	(d)	4.198	(a)	4.199	(d)	4.200	(c)
4.201	(d)	4.202	(b)	4.203	(d)	4.204	(a)	4.205	(a)	4.206	(a)	4.207	(b)	4.208	(c)
4.209	(d)	4.210	(d)	4.211	(c)	4.212	(a)	4.213	(a)	4.214	(c)	4.215	(a)	4.216	(d)
4.217	(b)	4.218	(a)	4.219	(d)	4.220	(a)	4.221	(d)	4.222	(d)	4.223	(c)	4.224	(b)
4.225	(c)	4.226	(b)	4.227	(a)	4.228	(a)	4.229	(a)	4.230	(a)	4.231	(c)	4.232	(b)
4.233	(b)	4.234	(a)	4.235	(c)	4.236	(d)	4.237	(d)	4.238	(d)	4.239	(b)	4.240	(c)
4.241	(c)	4.242	(a)	4.243	(d)	4.244	(d)	4.245	(a)	4.246	(a)	4.247	(c)	4.248	(a)
4.249	(b)	4.250	(b)	4.251	(b)	4.252	(b)	4.253	(c)	4.254	(a)	4.255	(c)	4.256	(a)
4.257	(c)	4.258	(d)	4.259	(d)	4.260	(c)	4.261	(a)	4.262	(a)	4.263	(b)	4.264	(d)
4.265	(c)	4.266	(a)	4.267	(a)	4.268	(c)	4.269	(d)	4.270	(d)	4.271	(d)	4.272	(d)
4.273	(d)	4.274	(b)	4.275	(b)	4.276	(d)	4.277	(b)	4.278	(c)				

5. Fractional Kilowatt Motors

5.1	(d)	5.2	(c)	5.3	(b)	5.4	(d)	5.5	(a)	5.6	(d)	5.7	(a)	5.8	(d)
5.9	(a)	5.10	(d)	5.11	(c)	5.12	(d)	5.13	(d)	5.14	(c)	5.15	(c)	5.16	(b)
5.17	(d)	5.18	(a)	5.19	(b)	5.20	(a)	5.21	(b)	5.22	(d)	5.23	(c)	5.24	(a)
5.25	(a)	5.26	(d)	5.27	(d)	5.28	(d)	5.29	(b)	5.30	(a)	5.31	(a)	5.32	(c)
5.33	(a)	5.34	(b)	5.35	(c)	5.36	(c)	5.37	(d)	5.38	(a)	5.39	(b)	5.40	(a)
5.41	(c)	5.42	(a)	5.43	(c)	5.44	(a)	5.45	(a)	5.46	(d)	5.47	(d)	5.48	(a)
5.49	(d)	5.50	(b)	5.51	(a)	5.52	(c)	5.53	(c)	5.54	(b)	5.55	(c)	5.56	(b)
5.57	(b)	5.58	(a)	5.59	(b)	5.60	(a)	5.61	(d)	5.62	(a)	5.63	(d)	5.64	(c)
5.65	(d)	5.66	(b)	5.67	(a)	5.68	(a)	5.69	(a)	5.70	(c)	5.71	(a)	5.72	(c)
5.73	(c)	5.74	(a)	5.75	(c)	5.76	(d)	5.77	(c)	5.78	(c)	5.79	(d)	5.80	(c)
5.81	(c)	5.82	(d)	5.83	(c)	5.84	(b)	5.85	(a)	5.86	(a)	5.87	(b)	5.88	(b)
5.89	(d)	5.90	(b)	5.91	(c)	5.92	(d)	5.93	(d)	5.94	(d)	5.95	(d)	5.96	(c)
5.97	(d)	5.98	(c)	5.99	(d)	5.100	(c)	5.101	(b)	5.102	(d)	5.103	(b)	5.104	(d)
5.105	(a)	5.106	(b)	5.107	(a)	5.108	(b)	5.109	(c)	5.110	(d)	5.111	(b)	5.112	(d)
5.113	(b)	5.114	(a)	5.115	(c)	5.116	(c)	5.117	(d)	5.118	(c)	5.119	(c)	5.120	(a)
5.121	(a)	5.122	(d)	5.123	(c)	5.124	(c)	5.125	(d)	5.126	(c)	5.127	(a)	5.128	(a)
5.129	(d)	5.130	(d)	5.131	(b)	5.132	(c)	5.133	(a)	5.134	(c)	5.135	(a)	5.136	(a)
5.137	(c)	5.138	(d)	5.139	(a)	5.140	(d)	5.141	(c)	5.142	(a)	5.143	(d)	5.144	(a)
5.145	(c)	5.146	(a)	5.147	(d)	5.148	(a)	5.149	(a)	5.150	(b)	5.151	(a)	5.152	(a)
5.153	(c)	5.154	(d)	5.155	(c)	5.156	(d)	5.157	(c)	5.158	(b)	5.159	(d)	5.160	(c)
5.161	(b)	5.162	(c)	5.163	(a)	5.164	(b)	5.165	(c)	5.166	(b)	5.167	(d)	5.168	(c)
5.169	(d)	5.170	(a)	5.171	(b)	5.172	(b)	5.173	(c)	5.174	(c)	5.175	(b)	5.176	(c)
5.177	(b)	5.178	(c)	5.179	(c)	5.180	(a)	5.181	(d)						

6. Miscellaneous

6.1	(d)	6.2	(d)	6.3	(d)	6.4	(a)	6.5	(d)	6.6	(b)	6.7	(a)	6.8	(a)
6.9	(c)	6.10	(a)	6.11	(b)	6.12	(b)	6.13	(b)	6.14	(d)	6.15	(d)	6.16	(c)
6.17	(a)	6.18	(d)	6.19	(d)	6.20	(b)	6.21	(c)	6.22	(b)	6.23	(c)	6.24	(a)
6.25	(d)	6.26	(a)	6.27	(b)	6.28	(a)	6.29	(c)	6.30	(b)	6.31	(d)	6.32	(b)
6.33	(c)	6.34	(d)	6.35	(a)	6.36	(b)	6.37	(a)	6.38	(c)	6.39	(a)	6.40	(d)
6.41	(d)	6.42	(b)	6.43	(b)	6.44	(d)	6.45	(c)	6.46	(b)	6.47	(c)	6.48	(d)
6.49	(c)	6.50	(a)	6.51	(c)	6.52	(b)	6.53	(c)	6.54	(a)	6.55	(b)	6.56	(a)
6.57	(b)	6.58	(c)	6.59	(a)	6.60	(d)	6.61	(c)	6.62	(d)	6.63	(c)	6.64	(d)
6.65	(b)	6.66	(c)	6.67	(d)	6.68	(d)	6.69	(c)	6.70	(c)	6.71	(a)	6.72	(c)
6.73	(a)	6.74	(b)	6.75	(d)	6.76	(b)	6.77	(a)	6.78	(a)	6.79	(d)	6.80	(b)
6.81	(d)	6.82	(a)	6.83	(d)	6.84	(b)	6.85	(a)	6.86	(d)	6.87	(d)	6.88	(b)
6.89	(d)														

Explanations **Electrical Machines**

1. Transformers

1.1 (a)

Method 1:

$\because$ Rating of auto transformer is given as

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

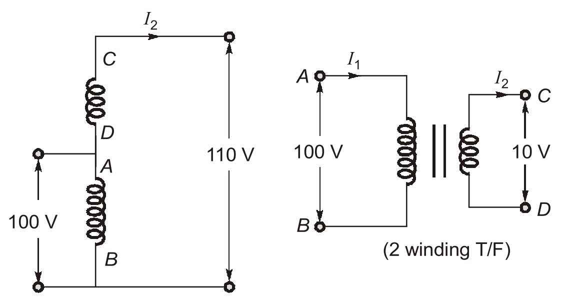
where, $a_{auto} = \frac{V_H}{V_L} = \frac{110}{100} = \frac{11}{10}$

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:



(2 winding T/F)

(Auto 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,

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

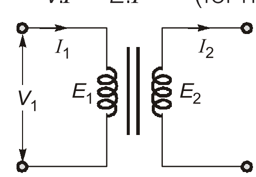
$$\Rightarrow I_{fl}^2 \cdot R = 6400 \text{ Watts}$$

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

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

$V = E$ is taken

So, rating is $E \cdot I$ kVA

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

so, kVA $\propto f$

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

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

or, $\text{kVA}_2 = 125$ 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 $P_{cu} = I_{fl}^2 \cdot R$

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

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

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

Now,

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

∴ for full load,

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

At half load,

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

(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.

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,

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

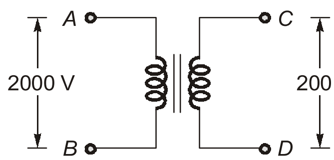
Note: For subtractive polarity $\left(\frac{2000}{1800}\right) = a_{auto}$

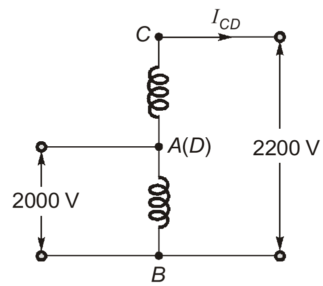
$\therefore \quad a_{auto} = \frac{10}{9} (> 1)$

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

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.,

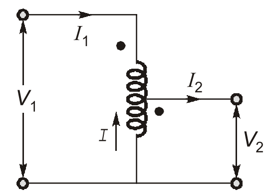
$$I = \frac{I_{FL}}{2}$$

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)



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

$\because \quad I_1 = 60$ 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,

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

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

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

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

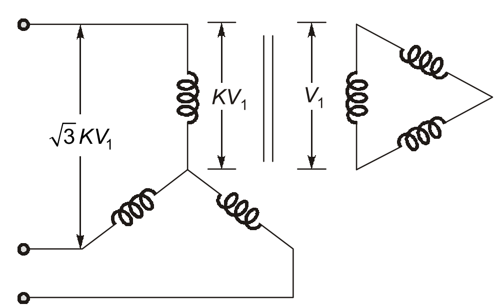
$$(R_{eq})_{HV} = r_1 + a^2 r_2 = 0.1 + (5)^2 \times 0.004 = 0.2\ \Omega$$

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 insulation 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)



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

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

1.27 (d)

Auto-transformation ratio,

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

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

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

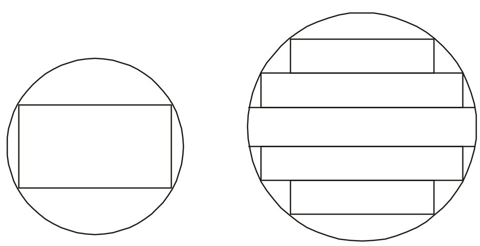
$$\propto \left(\frac{V_1 - V_2}{V_1}\right)$$

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

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

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

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

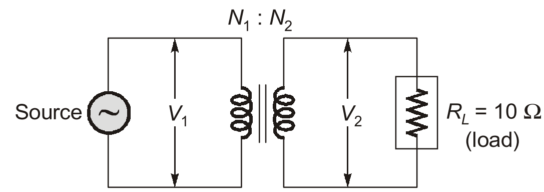
$$(V_L)_\Delta = V_{ph}$$

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

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

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

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 = $a = \dfrac{N_1}{N_2}$

When referred to load side:

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

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

For impedance matching,

$$R_s' = R_L$$

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

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

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.

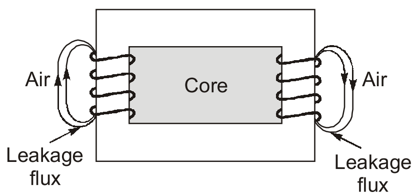
1.33 (d)

- 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., $\phi_{max} \propto \frac{1}{f}$

[For other parameters to be constant]

Also we know,

$$\phi_m = \text{B.A}$$

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

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

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. $\frac{N_p}{N_s} = \frac{20}{1} = \frac{100}{5} = \frac{40}{2} = ...$ 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, $I_p N_p = I_s N_s$

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

Hence, (c) is not correct.

1.45. (d)

$\because$ 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 voltage 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 increases 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.