POSTAL BOOK PACKAGE 2024

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1 CHAPTER

Transformers

MCQ and NAT Questions

Q.1 The power transformer is a
(a) constant voltage device
(b) constant main flux device
(c) constant current device
(d) constant power device

Q.2 P_i = core loss, P_c = copper loss. A transformer has maximum efficiency when
(a) $P_i/P_c = 2$ (b) $P_i/P_c = 15$
(c) $P_i/P_c = 1$ (d) $P_i/P_c = 0.5$

Q.3 For a single-phase transformer, r_e = total equivalent resistance, x_e = total equivalent leakage reactance, P_c = core loss. The load current at which maximum efficiency occurs is
(a) $\frac{P_c}{x_e}$ (b) $\sqrt{\frac{P_c}{x_e}}$
(c) $\frac{P_c}{r_e}$ (d) $\sqrt{\frac{P_c}{r_e}}$

Q.4 If the iron core of a transformer is replaced by an air core, then the hysteresis losses in the transformer will
(a) increase (b) decrease
(c) remain unchanged (d) become zero

Q.5 A 2 kVA transformer has iron loss of 150 Watts and full-load copper loss of 250 Watts. The maximum efficiency of the transformer would occur when the total loss is
(a) 500 W (b) 400 W
(c) 300 W (d) 275 W

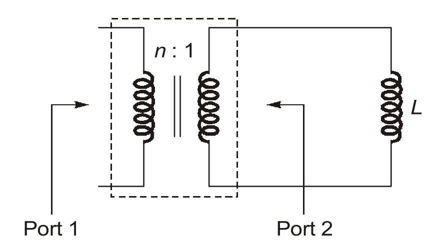
Q.6 A 1-phase 250/500 V transformer gave the following result. Open-circuit test 250 V, 1 A, 80 W on l.v. side what is the power factor?
(a) 0.24 (b) 0.32
(c) 0.28 (d) 0.30

Q.7 Which of the following is not true relating to an ideal transformer?
(a) The iron loss in an ideal transformer is zero
(b) The winding resistance has a zero value
(c) The leakage reactance has a non-zero value
(d) The magnetizing current is zero

Q.8 Two transformers with identical voltage ratings are working in parallel to supply a common load. The impedance of one transformer is higher compared to that of the other. The load sharing between the two transformers will
(a) be proportional to their impedances.
(b) be independent of their impedances.
(c) be inversely proportional to their respective impedances.
(d) depend on the resistance to leakage reactance ratio of each transformer.

Q.9 A 20 kVA, 2000/200 V transformer has name plate leakage impedance of 8% what voltage must be applied on the HV side to circulate full load current with the LV shorted:
(a) 200 V (b) 2000 V
(c) 160 V (d) 240 V

Q.10 If an ideal transformer has an inductive load element at port 2 as shown in the figure below, the equivalent inductance at port 1 is



(a) nL (b) n^2L
(c) $\frac{n}{L}$ (d) $\frac{n^2}{L}$

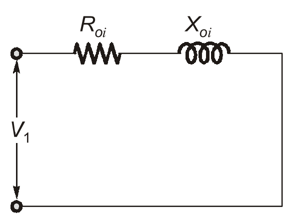
Q.11 A transformer operates most efficiently at 3/4th full-load. Its iron loss (P_i) and full-load copper loss (P_c) are related as:
(a) $P_i/P_c = 16/9$ (b) $P_i/P_c = 4/3$
(c) $P_i/P_c = 3/4$ (d) $P_i/P_c = 9/16$

Q.12 The efficiency of transformer during no load and short-circuit test is
(a) maximum (b) 50%
(c) zero (d) none of the above

Q.13 During open-circuit test in a transformer the wattmeter used is of
(a) low p.f. wattmeter type
(b) high p.f. wattmeter type
(c) medium p.f. wattmeter type
(d) very high p.f. wattmeter type

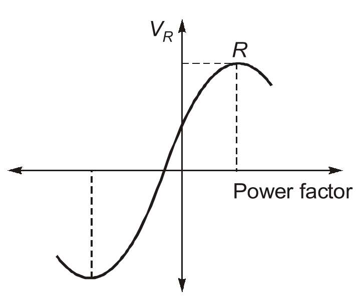
Q.14 Find the reactive component of no-load current for a 440/220 V single-phase transformer if power input to H.V. winding is 110 W. The low voltage winding is kept open. The p.f. of no-load current is 0.6 lagging.
(a) 0.578 A (b) 0.80 A
(c) 0.33 A (d) 0.427 A

Q.15 At which condition of the transformer the equivalent circuit will be as shown in the below figure?



(a) Under short circuit (b) Under open circuit
(c) Under no load (d) Under rated load

Q.16 A 2300/230 V single phase transformer has resistance and reactance 0.05 p.u. and 0.5 p.u. respectively. Voltage regulation versus load power factor plot is shown below:



At point R, power factor of load is
(a) 0.995 lagging (b) 0.0995 lagging
(c) 0.0995 leading (d) 0.995 leading

Q.17 A 50 kVA transformer has a core loss of 600 W and a full-load copper loss of 900 W. The proportion of full load at maximum efficiency is
(a) 91.03% (b) 72.16%
(c) 81.64% (d) 68.45%

Q.18 The full load copper loss and core loss of a transformer are 3200 W and 1500 W respectively. The total loss (neglecting stray losses) at 3/4th of full load is ________ W.

Q.19 A 300 kVA transformer has a core loss of 1.5 kW and a full load copper loss of 4.5 kW, the maximum efficiency of the transformer is _______ %.

Q.20 Which of these following transformers for per unit loading will reach full load first?
(a) 1000 kVA, $Z = 2\ \Omega$
(b) 5000 kVA, $Z = 4\ \Omega$
(c) 2000 kVA, $Z = 1.5\ \Omega$
(d) 4000 kVA, $Z = 1\ \Omega$

Q.21 A transformer has percentage reactance of 4% and percentage resistance of 2%. The voltage regulations at pf 0.6 lead and 0.6 lag respectively are
(a) 4.4%, –2% (b) –2.4%, 0.8%
(c) –2%, 4.4% (d) 0.8%, –2.4%

Q.22 A 200 V/100 V, 50 Hz transformer is to be excited at 40 Hz from 100 V side. For the exciting current to be the same, the applied voltage should be
(a) 150 V (b) 80 V
(c) 100 V (d) 125 V

Q.23 Eddy current losses in transformer cores can be reduced by the use of
1. Solid cores
2. Laminated cores
3. Ferrites

Select the correct answer using the codes given below:
(a) 2 and 3 only (b) 1 and 2 only
(c) 1 and 3 only (d) 1, 2 and 3

Q.24 No load current in a transformer
(a) lags the applied voltage by 90°
(b) lags the applied voltage by somewhat less than 90°
(c) leads the applied voltage by 90°
(d) leads the applied voltages by somewhat less than 90°

Q.25 A 100 kVA, 1000 V/400 V, 1-ϕ transformer when excited at rated voltage on *h.v.* side, draws a no load current of 3.0 A at 0.75 lagging power factor. If it is excited from the *l.v.* side at rated voltage, the no load current and power factor will be respectively,
(a) 7.5 A, 0.6 lag (b) 7.5 A, 0.75 lag
(c) 6.5 A, 0.70 lag (d) 6.5 A, 0.75 lag

Answers Transformers

1.	(b)	2.	(c)	3.	(d)	4.	(d)	5.	(c)	6.	(b)	7.	(c)
8.	(c)	9.	(c)	10.	(b)	11.	(d)	12.	(c)	13.	(a)	14.	(c)
15.	(a)	16.	(b)	17.	(c)	18.	(3300)	19.	(98.29)	20.	(a)	21.	(c)
22.	(b)	23.	(a)	24.	(b)	25.	(b)	26.	(d)	27.	(18)	28.	(d)
29.	(c)	30.	(d)	31.	(15.65)	32.	(6.02)	33.	(b)	34.	(d)	35.	(d)
36.	(a)	37.	(3.556)	38.	(95.92)	39.	(a)	40.	(1.2)	41.	(b)	42.	(a)
43.	(c)	44.	(151.95)	45.	(b)	46.	(a)	47.	(1.44)	48.	(b)	49.	(c)
50.	(c)	51.	(a)	52.	(c)	53.	(2.4)	54.	(23.61)	55.	(a, b)	56.	(a, c)
57.	(b, c, d)	58.	(a, b, c)										

Explanations Transformers

1. (b)

Transformer is a static device which cannot change frequency, but can change voltage and current level of the system. Practically, transformer is a constant flux machine. However due to losses in transformer, power at both sides may vary. Hence (b) is better option.

2. (c)

In a transformer, condition for maximum efficiency is copper loss or variable loss = iron loss

Thus, $P_i = P_c$

or $\frac{P_i}{P_c} = 1$

3. (d)

At η_{max},

Copper loss = Iron loss

or, $I_m^2 r_e = P_c$

or, $I_m = \sqrt{\frac{P_c}{r_e}}$

4. (d)

Air-core means non-iron core so there will be no hysteresis losses.

5. (c)

For maximum efficiency at full load

$$P_{cu} = P_i = 150 \text{ W}$$

$$\text{Total loss} = P_i + P_{cu} = 150 + 150 = 300 \text{ W}$$

6. (b)

Given: $V_{NL} = 250$ V ; $I_{NL} = 1$ A ; $P_{NL} = 80$ W

For OC test: $P_{NL} = V_{NL} I_{NL} \cdot \cos\phi$

$$\cos\phi = \text{pf on LV side}$$

$$= \frac{80}{250 \times 1} = 0.32$$

7. (c)

In an ideal transformer there is no-loss (either in winding or core). The leakage reactance is also zero (as no-voltage drop).

Magnetizing current is zero due to infinite permeability of core.

8. (c)

$$\text{kVA shared} \propto \frac{1}{\text{leakage impedance}}$$

9. (c)

Given, $\frac{Z_{HV(\Omega)} I_{HV(rated)}}{V_{HV(rated)}} = 0.08$

$$Z_{HV(\Omega)} \cdot I_{HV(rated)} = 0.08\, V_{HV(rated)}$$

$$V_{SC} = 0.08 \times 2000 = 160 \text{ V}$$

10. (b)

In an ideal transformer,

$$Z \propto N^2$$

Given, on port 2:

$$Z_2 = \omega L \text{ i.e. } Z_2 \propto L$$

$$\frac{N_1}{N_2} = n : 1 = n$$

$$\frac{Z_1}{Z_2} = \left(\frac{N_1}{N_2}\right)^2$$
$$Z_1 = (Z_2)\,[n]^2$$
$$Z_1 = (\omega L)\,(n^2)$$
X_{L1} = equivalent inductance at port 1:
$$= \frac{Z_1}{\omega} = n^2 L$$

11. (d)

For maximum efficiency,
$$P_i = x^2 P_{cu}$$
$$\Rightarrow \quad P_i = P_{cu} \text{ (for full load)}$$
For 3/4th full load,
$$P_i = \left(\frac{3}{4}\right)^2 P_{cu}$$
$$\frac{P_i}{P_{cu}} = \frac{9}{16}$$

12. (c)

SC test is carried out to determine the full load copper loss and OC test or NL test to determine core loss. During these tests, power required is used to determine the losses and efficiency will be zero.

13. (a)

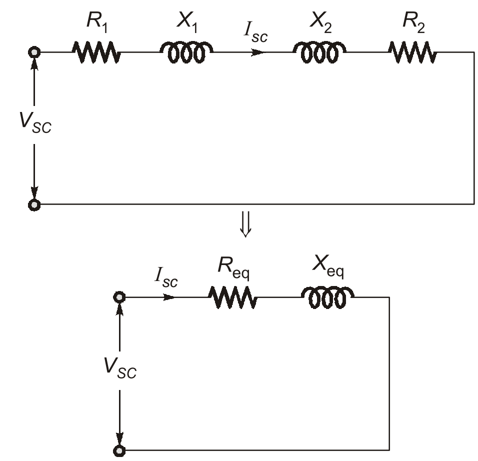
During open circuit test or no load test, it is recommended to use low power factor wattmeter. This is because NL power factor is very low and thus less deflecting torque ($T_d \,\alpha\, I_1 I_2 \cos\phi$) will be there. Hence LPF wattmeters employed for OC test. On the other hand, for short circuit test, high pf wattmeters are employed.

14. (c)

Given, $P_0 = 110$ W, $V_0 = 440$ V
$\cos\phi_0 = 0.6$ (lag)
$\because$ At NL test, $P_0 = V_0 I_0 \cos\phi_0$
No load current,
$$I_0 = \frac{110}{440 \times 0.6} = 0.4166 \text{ A}$$
Let reactive component of no-load current = I_m
$$I_m = I_0 \sin\phi_0$$
$$= 0.4166 \times 0.8 = 0.33 \text{ A}$$

15. (a)

- SC test is conducted at H.V. side to find out the total resistance and reactance of transformer.
- Equivalent circuit during S.C. condition.



16. (b)

Point R is corresponding to maximum voltage regulation.
For maximum voltage regulation load power factor is equal to
$$\cos\phi = \frac{R}{Z}$$
$$Z = \sqrt{R^2 + X^2} = \sqrt{0.05^2 + 0.5^2}$$
Power factor,
$$\cos\phi = 0.0995 \text{ lagging}$$

17. (c)

Proportion of full load at maximum efficiency,
$$x = \sqrt{\frac{P_i}{P_{cu(fl)}}} = \sqrt{\frac{600}{900}}$$
$$= 0.8164 = 81.64\%$$

18. (3300)

Given, $P_i = 1500$ W, $P_{CFL} = 3200$ W

At $\frac{3}{4}$th of full load,
$$\text{Copper losses} = P_C' = 3200 \times \left(\frac{3}{4}\right)^2 = 1800 \text{ W}$$
But iron losses or core losses will be same

Total losses at $\frac{3}{4}$th of full load
$$= P_C' + P_i$$
$$= 1800 + 1500 = 3300 \text{ W}$$

19. (98.29)

Maximum efficiency occurs at unity power factor and when copper loss is equal to the iron loss kVA rating at maximum efficiency

$$S_m = S_{fl}\sqrt{\frac{P_i}{P_{cu}}}$$

$$= 300 \times \sqrt{\frac{1.5}{4.5}} = 173.205 \text{ kVA}$$

$$\therefore \text{Maximum efficiency} = \frac{\text{Power output}}{\text{Power output} + \text{losses}}$$

$$\%\ \eta_{max} = \frac{173.205}{173.205 + 1.5 + 1.5} \times 100$$

$$= 98.29\%$$

20. (a)

For per unit loading,

$$S_{f\text{ p.u.}} \propto \frac{1}{(Z_\Omega) \times (S_{f\text{rated}})}$$

For option:

(a) $Z_\Omega \times S_{f\text{rated}} = 1000 \times 2 = 2000$

(b) $Z_\Omega \times S_{f\text{rated}} = 5000 \times 4 = 20000$

(c) $Z_\Omega \times S_{f\text{rated}} = 2000 \times 1.5 = 3000$

(d) $Z_\Omega \times S_{f\text{rated}} = 4000 \times 1 = 4000$

Hence, (a) will reach full load first as the product is lowest for option (a).

21. (c)

For lagging load,

$$\%\text{ V.R.} = (R_{epu} \cos\phi + X_{epu} \sin\phi) \times 100$$

For leading load,

$$\%\text{ V.R.} = (R_{epu} \cos\phi - X_{epu} \sin\phi) \times 100$$

Given, $R_{e\,pu} = 0.02$, $X_{e\,pu} = 0.04$, $\cos\phi = 0.6$

For lagging load,

$$\%\text{ V.R.} = (0.02 \times 0.6 + 0.04 \times 0.8) \times 100 = 4.4\%$$

For leading load,

$$\%\text{ V.R.} = (0.02 \times 0.6 - 0.04 \times 0.8) \times 100 = -2\%$$

22. (b)

For the exciting current to be same, the flux in the core should be constant as

$$V = \sqrt{2}\pi N f \phi_m$$

$$\Rightarrow \quad \frac{V}{f} = \text{Constant}$$

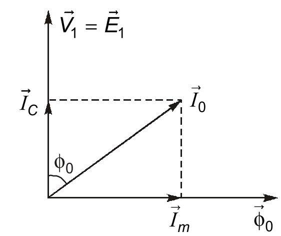
$$\therefore \quad \frac{100}{50} = \frac{V}{40} \Rightarrow V = 80 \text{ V}$$

23. (a)

Eddy current losses in transformer cores can be reduced by the use of laminated cores and ferrites.

24. (b)

No load phasor diagram:



Here, no load current (I_0) cannot lag $\vec{V}_1$ by 90° because of core loss. In practical transformer,

$$\phi_0 = 80° - 85°$$

25. (b)

When *h.v.* side is excited,

$$\text{core loss} = VI\cos\phi = 1000 \times 3 \times 0.75 = 2250 \text{ W}$$

When *l.v.* side is excited,

$$\text{core loss} = VI\cos\phi = 2250 \text{ W}$$

$$I = \frac{2250}{V \times \cos\phi} = \frac{2250}{400 \times 0.75} = 7.5 \text{ A}$$

Power factor is same for a transformer.

26. (d)

Full load current,

$$I_{fl} = \frac{12 \times 10^3}{2200} = 5.45 \text{ A}$$

Short circuit test is conducted at $I = 4.09$ A

Full load short circuit losses,

$$P_{cu} = 150 \times \left(\frac{5.45}{4.09}\right)^2 = 266.34 \text{ W}$$

$$\text{Efficiency, } \eta = \frac{12000 \times 0.8}{12000 \times 0.8 + 80 + 266.34} = 96.51\%$$

27. (18)

Given, $N_2 = 100$, $f = 50$ Hz, $E_2 = 400$ V

$\because$ RMS value of induced emf