6. A small electrically heated drying oven has two independent heating elements each of 1000 Ω in its heating unit. Switching is provided so that the oven temperature can be altered by rearranging the resistor connections. How many different heating positions can be obtained and what is the electrical power drawn in each arrangement from a 200 V battery of negligible resistance ?

[Three, 40, 20 and 80 W]

7. Ten electric heaters, each taking 200 W were used to dry out on site an electric machine which had been exposed to a water spray. They were used for 60 hours on a 240 V supply at a cost of twenty paise/kWh. Calculate the values of following quantities involved :
(*a*) current (*b*) power in kW (*c*) energy in kWh (*d*) cost of energy.

[(*a*) 8.33 A (*b*) 2 kW (*c*) 120 kWh (*d*) Rs. 24]

8. An electric furnace smelts 1000 kg of tin per hour. If the furnace takes 50 kW of power from the electric supply, calculate its efficiency, given : the smelting tempt. of tin = 235°C ; latent heat of fusion = 13.31 kcal/kg; initial temperature = 15°C ; specific heat = 0.056. Take J = 4200 J/kcal.

[59.8%] *(Electrical Engg.-I, Delhi Univ.)*

9. Find the useful rating of a tin-smelting furnace in order to smelt 50 kg of tin per hour. Given : Smelting temperature of tin = 235°C, Specific heat of tin = 0.055 kcal/kg-K. Latent heat of liquefaction = 13.31 kcal per kg. Take initial temperature of metal as 15°C. **[1.5 kW]**

(F.Y. Engg. Pune Univ.)

10. State the relation between
(*i*) Kcal and kWh (*ii*) Horse power and watts (*iii*) kWh and joule (watt sec) (*iv*) K.E and joules.

(Gujrat University, Summer 2003)

11. The electrical load in a small workshop consists of 14 lamps, each rated at 240 V, 60 W and 3 fans each rated at 240 V, 1 kW. What is the effective resistance of the total load, total current and energy utilised if run for 8 hrs.

(Pune University 2003) (Gujrat University, Summer 2003)

OBJECTIVE TESTS – 3

1. If a 220 V heater is used on 110 V supply, heat produced by it will be —— as much.
(*a*) one-half (*b*) twice
(*c*) one-fourth (*d*) four times

2. For a given line voltage, four heating coils will produce maximum heat when connected
(*a*) all in parallel (*b*) all in series
(*c*) with two parallel pairs in series
(*d*) one pair in parallel with the other two in series

3. The electric energy required to raise the temperature of a given amount of water is 1000 kWh. If heat losses are 25%, the total heating energy required is — kWh.
(*a*) 1500 (*b*) 1250
(*c*) 1333 (*d*) 1000

4. One kWh of energy equals nearly
(*a*) 1000 W (*b*) 860 kcal
(*c*) 4186 J (*d*) 735.5 W

5. One kWh of electric energy equals
(*a*) 3600 J (*b*) 860 kcal
(*c*) 3600 W (*d*) 4186 J

6. A force of 10,000 N accelerates a body to a velocity 0.1 km/s. This power developed is —— kW
(*a*) 1,00,000 (*b*) 36,000
(*c*) 3600 (*d*) 1000

7. A 100 W light bulb burns on an average of 10 hours a day for one week. The weekly consumption of energy will be —— unit/s
(*a*) 7 (*b*) 70
(*c*) 0.7 (*d*) 0.07

(Principles of Elect. Engg. Delhi Univ.)

8. Two heaters, rated at 1000 W, 250 volts each, are connected in series across a 250 Volts 50 Hz A.C. mains. The total power drawn from the supply would be ——— watt.,
(*a*) 1000 (*b*) 500
(*c*) 250 (*d*) 2000

(Principles of Elect. Engg. Delhi Univ.)

ANSWERS

1. *c* **2.** *a* **3.** *c* **4.** *b* **5.** *b* **6.** *d* **7.** *a* **8.** *b*

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25. A steel wire of 25 cm mean diameter and circular cross section 3 cm in diameter has an airgap of 1 mm wide. It is wound with a coil of 700 turns carrying a current of 2 A.
Calculate : (*i*) m.m.f. (*ii*) Flux density (*iii*) Reluctance (*iv*) Relative permeability.
Assume that iron path take 30% of total m.m.f. *(Gujrat University,Summer 2003)*

26. What is a search coil in magnetic measurements? *(Anna University, April 2002)*

27. Name the magnestic squares used to find iron loss. *(Anna University, April 2002)*

28. What is a magnetic circuit? A magnetic circuit is made up of 3 limbs A, B and C in prallel. The reluctances of the magnetic paths of A, B and C in AT/mWb are 312, 632.6 and 520 respectively. An exciting coil of 680 turns is wound on limb B. Find the exciting current to produce of flux of lmwb in the limb A. *(V.T.U., Belgaum Karnataka University, February 2002)*

29. An iron ring of 300cm mean circumference with a cross section of $5cm^2$ is wound uniformly with 350 turns of wire. Find the current required to produce a flux of 0.5 Mwb in iron. Take relative permeability of iron as 400. *(V.T.U. Belgaum Karnataka University, July/August 2002)*

30. What is Biot-Savart law? Explain briefly. Find the magnetic field due to a small circular loop carrying current I at distances from loop that are large compared with its dimensions.
(Agra Univ. 1978 Supp.)

31. Magnetic potential *(Mumbai University, 2002) (RGPV, Bhopal 2001)*

32. Flux density *(Pune University,2002) (RGPV, Bhopal 2001)*

33. Susceptibility *(Mumbai University, 2002) (RGPV, Bhopal 2001)*

34. Define mm*f*, flux, reluctance, absolute and relative permeabilities with reference to magnetic circuits.
(U.P. Technical University 2003) (RGPV, Bhopal 2002)

35. Discuss B-H curve of a ferro-magnetic material and explain the following.
(*i*) Magnetic saturation (*ii*) Hysteresis (*iii*) Residual magnetism (*iv*) Coercive force
(RGPV, Bhopal 2002)

36. What is meant by leakage and fringing? Define leakage coefficient.
(RGPV, Bhopal 2002)

37. Define the following terms (any five) :
(*i*) MMF (*ii*) Reluctance (*iii*) Permeance (*iv*) Magnetisation curve (*v*) flux density
(*vi*) Magnetizing force (*vii*) Susceptibility (*viii*) Relative permeability (*ix*) Magnetic potential
(RGPV, Bhopal 2002)

38. Distinguish between leakage and fringing of flux. *(RGPV, Bhopal 2002)*

39. Explain fringing of magnetic flux, magnetic leakage, staturation of ferowegnetic materials, B-H Curve, hysteresis and eddy current losses. *(RGPV, Bhopal 2003)*

OBJECTIVE TESTS – 6

1. Relative permeability of vacuum is
(*a*) $4\pi \times 10^{-7}$ H/m (*b*) 1 H/m
(*c*) 1 (*d*) 1/4 π

2. Unit of magnetic flux is
(*a*) weber (*b*) ampere-turn
(*c*) tesla (*d*) coulomb

3. Point out the WRONG statement.
The magnetising force at the centre of a circular coil varies.
(*a*) directly as the number of its turns
(*b*) directly as the current
(*c*) directly as its radius
(*d*) inversely as its radius

4. A pole of driving point admittance function implies
(*a*) zero current for a finite value of driving voltage
(*b*) zero voltage for a finite value of driving current
(*c*) an open circuit condition
(*d*) None of (*a*), (*b*) and (*c*) mentioned in the question *(ESE 2001)*

ANSWERS

1. *c* **2.** *a* **3.** *a*

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8. Derive an expression for the RMS value of a sine wave.
(V.T.U., Belgaum Karnataka University, Summer 2002)
9. With a neat sketch briefly explain how an alternating voltage is produced when a coil is rotated in a magnetic field. *(V.T.U., Belgaum Karnataka University, Summer 2003)*
10. Derive expressions for average value and RMS value of a sinusoidally varying AC voltage.
(V.T.U., Belgaum Karnataka University, Summer 2003)
11. A circuit having a resistance of 12Ω, an inductance of 0.15 H and a capacitance of 100μ*f* in series is connected across a 100V, 50Hz supply. Calculate the impedance, current, the phase difference between the current and supply voltage.
(V.T.U., Belgaum Karnataka University, Summer 2003)
12. Two circuits with impedances of $Z_1 = 10 + j15\Omega$ and $Z_2 = 6 - j8\Omega$ are connected in parallel. If the supply current is 20A, what is the power dissipated in each branch?
(V.T.U., Belgaum Karnataka University, Summer 2003)
13. Show that the power consumed in a pure inductance is zero.
(U.P. TechnicalUniversity 2002) (RGPV Bhopal 2002)
14. What do you understand by the terms power factor, active power and reactive power?
(U.P. TechnicalUniversity 2002) (RGPV Bhopal 2002)
15. Current flowing through each line.
(RGPV Bhopal December 2002)
16. Distinguish between (*i*) apparent power (*ii*) active power and (*iii*) reactive power in A.C. circuits.
(U.P. TechnicalUniversity 2002) (RGPV Bhopal June 2003)

OBJECTIVE TESTS – 11

1. An a.c. current given by $i = 14.14 \sin(\omega t + \pi/6)$ has an r.m.s value of — amperes.
(*a*) 10
(*b*) 14.14
(*c*) 1.96
(*d*) 7.07
and a phase of — degrees.
(*e*) 180
(*f*) 30
(*g*) – 30
(*h*) 210
2. If $e_1 = A \sin \omega t$ and $e_2 = B \sin(\omega t - \phi)$, then
(*a*) e_1 lags e_2 by θ
(*b*) e_2 lags e_1 by θ
(*c*) e_2 leads e_2 by θ
(*d*) e_1 is in phase with e_2
3. From the two voltage equations $e_A = E_m \sin 100\pi t$ and $e_B = E_m \sin(100\pi t + \pi/6)$, it is obvious that
(*a*) *A* leads *B* by 30°
(*b*) *B* achieves its maximum value 1/600 second before *A* does.
(*c*) *B* lags behind *A*
(*d*) *A* achieves its zero value 1/600 second before *B*.
4. The r.m.s. value of a half-wave rectified current is 10A, its value for full-wave rectification would be — amperes.
(*a*) 20
(*b*) 14.14
(*c*) $20/\pi$
(*d*) $40/\pi$
5. A resultant current is made of two components : a 10 *A* d.c. component and a sinusoidal component of maximum value 14.14 A. The average value of the resultant current is — amperes.
(*a*) 0 (*b*) 24.14
(*c*) 10 (*d*) 4.14
and r.m.s. value is — amperes.
(*e*) 10 (*f*) 14.14
(*g*) 24.14 (*h*) 100
6. The r.m.s. value of sinusoidal a.c. current is equal to its value at an angle of — degree
(*a*) 60 (*b*) 45 (*c*) 30 (*d*) 90
7. Two sinusoidal currents are given by the equations : $i_2 = 10 \sin(\omega t + \pi/3)$ and $i_2 = 15 \sin(\omega t - \pi/4)$. The phase difference between them is — degrees.
(*a*) 105
(*b*) 75
(*c*) 15
(*d*) 60

8. As sine wave has a frequency of 50 Hz. Its angular frequency is — radian/second.

(*a*) $50/\pi$

(*b*) $50/2\ \pi$

(*c*) $50\ \pi$

(*d*) $100\ \pi$

9. An a.c. current is given by $i = 100 \sin 100$. It will achieve a value of 50 A after — second.

(*a*) 1/600

(*b*) 1/300

(*c*) 1/1800

(*d*) 1/900

10. The reactance offered by a capacitor to alternating current of frequency 50 Hz is 10Ω. If frequency is increased to 100 Hz reactance becomes—ohm.

(*a*) 20 (*b*) 5

(*c*) 2.5 (*d*) 40

11. A complex current wave is given by $i = 5 + 5 \sin 100\ \pi t$ ampere. Its average value is — ampere.

(*a*) 10 (*b*) 0

(*c*) $\sqrt{50}$ (*d*) 5

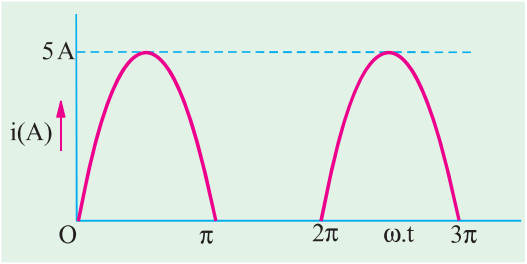

Fig. 11.67

12. The current through a resistor has a waveform as shown in Fig. 11.67. The reading shown by a moving coil ammeter will be— ampere.

(*a*) $5/\sqrt{2}$ (*b*) $2.5/\sqrt{2}$

(*c*) $5/\pi$ (*d*) 5

(Principles of Elect. Engg. Delhi Univ.)

ANSWERS

1. *a, f* **2.** *b* **3.** *b* **4.** *b* **5.** *c, f* **6.** *b* **7.** *a* **8.** *d* **9.** *a* **10.** *b*
11. *d* **12.** *c*

Top

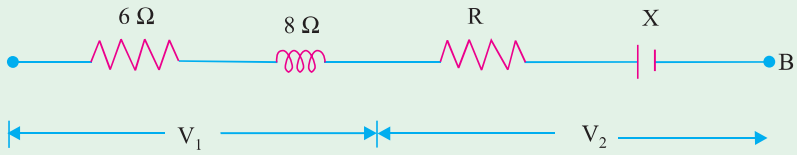

Fig. 13.54

20. A choke coil takes a current of 2 A lagging 60^0 behind the applied voltage of 220V at 50Hz. Calculate the inductance and resistance of the coil. *(V.T.U., Belgaum Karnataka University Winter 2003)*

21. The instantaneous values ofthe voltage across a two element series circum and the current flowing through it are given by $V = 100 \sin (314t - \pi/4)V$, $i = 20sin\ (314t - 90^0)A$. Find the frequency and the circuit elements. *(V.T.U., Belgaum Karnataka University, Winter 2003)*

22. Show that the power consumed in a pure inductance is zero. *(U.P. TechnicalUniversity 2003) (RGPV Bhopal 2002)*

23. What do you understand by the terms power factor, active power and reactive power? *(Mumbai University 2003) (RGPV Bhopal 2002)*

24. Series R-L-C circuit *(Mumbai University 2003) (RGPV Bhopal 2002)*

25. Describe the properties of (*i*) Resistance (*ii*) Inductance and (*iii*) capacitance used in A.C. Circuit. *(RGPV Bhopal June 2003)*

26. Define Apparant Power and Power factor in a.c. circuit. Describe parallel resonance and list its important properties. *(Mumbai University 2003) (RGPV Bhopal December 2003)*

OBJECTIVE TESTS -13

1. In a series *R-L* circuit, V_L—V_R by—degrees.
(*a*) lags, 45 (*b*) lags, 90
(*c*) leads, 90 (*d*) leads, 45

2. The voltage applied across an *R-L* circuit is equal to—of V_R and V_L.
(*a*) arithmetic sum (*b*) algebraic sum
(*c*) phasor sum (*d*) sum of the squares.

3. The power in an a.c. circuit is given by
(*a*) $VI \cos \phi$ (*b*) $VI \sin \phi$
(*c*) I^2Z (*d*) I^2X_L

4. The p.f. of an *R-C* circuit is
(*a*) often zero
(*b*) between zero and 1
(*c*) always unity
(*d*) between zero and –1.0

5. In a series RLC circuit at resonance, the magnitude of the voltage developed across the capacitor
(*a*) is always zero
(*b*) can never be greater than the input voltage.
(*c*) can be greater than the input voltage, however, it is 90^0 out of phase with the input voltage
(*d*) can be greater than the input voltage,and in in phase with the input voltage. *(GATE 2001)*

6. The total impedance Z (jω) of the circuit shown above is

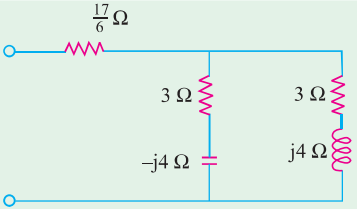

Fig. 13.55

(*a*) $(6 + j0)\ \Omega$ (*b*) $(7 + j0)\ \Omega$
(*c*) $(0 + j8)\ \Omega$ (*d*) $(6 + j8)\ \Omega$
(ESE 2003)

7. The impedance of a parallel RC network is $Z(s) = \dfrac{58}{s^2 + 0.5s + 100}$. Then the values of R, L and C are, respectively

(*a*) $10\ \Omega, \dfrac{1}{20}\text{H}, \dfrac{1}{5}\text{F}$ (*b*) $1\ \Omega, \dfrac{1}{2}\text{H}, \dfrac{1}{5}\text{F}$

(*c*) $10\ \Omega, \dfrac{1}{20}\text{H}, \dfrac{1}{5}\text{F}$ (*d*) $2\ \Omega, \dfrac{1}{20}\text{H}, \dfrac{1}{5}\text{F}$

(Engineering Services Exam. 2003)

ANSWERS

1. *c* **2.** *c* **3.** *a* **4.** *b*

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22. The currents is each branch of a two branched parallel circuit is given as :

$$i_a = 8.07 \sin\left(314\,t - \frac{\pi}{4}\right)$$

$$i_b - 21.2 \sin\left(314\,t - \frac{\pi}{3}\right)$$

and supply voltage is v = 354 sin 314 t.
Calculate :
(*i*) Total current in the same form (*ii*) Calculate ohmic value of components in each branch.
(Nagpur University, Summer 2004)

23. Two coils are connected in parallel and a voltage of 200 V is applied between the terminals the total current taken by the circuit is 25 A and power dissipated in one of the coils is 1500 W. Calculate the resistance of each coil. *(Gujrat University, June/July 2003)*

24. Compare the series and parallel resonance of R-L-C series and R-L-C parallel circuit.
(Gujrat University, June/July 2003)

25. Two circuits with impedances $Z_1 = (10 + r15)\ \Omega$ *and* $z_2 = (6 - r8_\Omega)$ are connected in parallel. If the supply current is 20A, what is the power dissipated in each branch.
(V.T.U., Belgaum Karnataka University, Winter 2003)

26. Three impedances $z_1 = 8 + j6\Omega$, $z_2 = 2 - j1.5\Omega$ and $z_3 = 2\Omega$ are connected in parallel across a 50Hz supply. If the current through z_1 is $3 + j4$amp, calculate the current through the other impedances and also power absorbed by this parallel circuit.
(V.T.U. Belgaum Karnataka University, Winter 2004)

27. Show that the power consumed in a pure inductance is zero.
(RGPV Bhopal 2002)

28. What do you understand by the terms power factor, active power and reactive power?
(RGPV Bhopal 2002)

29. Two circuits the impedances of which are given by $Z_1\ (10 + j\,15)\Omega$ and $Z_2 = (6 - j\,8)\Omega$ are connected in parallel. If the total current supplied is 15 A. What is the power taken by each branch?
(RGPV Bhopal 2002)

30. Does an inductance draw instantaneous power as well as average power?
(RGPV Bhopal December 2002)

31. Describe the properties of (*i*) Resistance (*ii*) Inductance and (*iii*) capacitance used in A.C. Circuit.
(RGPV Bhopal June 2003)

OBJECTIVE TYPES – 14

1. Fill in the blanks
(*a*) unit of admittance is .....
(*b*) unit of capacitive susceptance is .....
(*c*) admittance equals the reciprocal of .....
(*d*) admittance is given by the ..... sum of conductance and susceptance.

2. An *R-L* circuit has **Z** = (6 + *j*8) ohm. Its susceptance is -Siemens.
(*a*) 0.06 (*b*) 0.08 (*c*) 0.1 (*d*) -0.08

3. The impedances of two parallel branches of a circuit are (10 + *j*10) and (10 – *j*10) respectively. The impedance of the parallel combination is
(*a*) 20 + *j*0 (*b*) 10 + *j*0
(*c*) 5 – *j*5 (*d*) 0 – *j*20

4. The value of Z in Fig. 14.64 which is most appropriate to cause parallel resonance at 500 Hz is

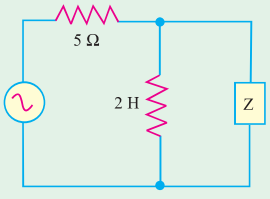

Fig. 14.64

(*a*) 125.00 mH (*b*) 304.20 μF
(*c*) 2.0 μF (*d*) 0.05 μF
(GATE 2004)

Top

15. A 1500 kW, 550-V, 16 pole generator runs at 150 rev. per min. What must be the useful flux if there are 2500 conductors lap-connected and the full-load copper losses are 25 kW? Calculate the area of the pole shoe if the gap density has a uniform value of 0.9 wb/m^2 and find the no-load terminal voltage, neglecting armature reaction and change in speed.

(Rajiv Gandhi Techn. Univ., Bhopal, 2000) **[0.09944 m^2, 559.17 V]**

OBJECTIVE TESTS – 26

1. The basic requirement of a d.c. armature winding is that it must be
(*a*) a closed one
(*b*) a lap winding
(*c*) a wave winding
(*d*) either (*b*) or (*c*)

2. A wave winding must go at least ..... around the armature before it closes back where it started.
(*a*) once
(*b*) twice
(*c*) thrice
(*d*) four times

3. The d.c. armature winding in which coil sides are a pole pitch apart is called ..... winding.
(*a*) multiplex
(*b*) fractional-pitch
(*c*) full-pitch
(*d*) pole-pitch

4. For making coil span equal to a pole pitch in the armature winding of a d.c. generator, the back pitch of the winding must equal the number of
(*a*) commutator bars per pole
(*b*) winding elements
(*c*) armature conductors per path
(*d*) armature parallel paths.

5. The primary reason for making the coil span of a d.c. armature winding equal to a pole pitch is to
(*a*) obtain a coil span of 180° (electrical)
(*b*) ensure the addition of e.m.fs. of consecutive turns
(*c*) distribute the winding uniformly under different poles
(*d*) obtain a full-pitch winding.

6. In a 4-pole, 35 slot d.c. armature, 180 electrical-degree coil span will be obtained when coils occupy ..... slots.
(*a*) 1 and 10
(*b*) 1 and 9
(*c*) 2 and 11
(*d*) 3 and 12

7. The armature of a d.c. generator has a 2-layer lap-winding housed in 72 slots with six conductors/slot. What is the minimum number of commutator bars required for the armature?
(*a*) 72
(*b*) 432
(*c*) 216
(*d*) 36

8. The sole purpose of a commutator in a d.c. Generator is to
(*a*) increase output voltage
(*b*) reduce sparking at brushes
(*c*) provide smoother output
(*d*) convert the induced a.c. into d.c.

9. For a 4-pole, 2-layer, d.c., lap-winding with 20 slots and one conductor per layer, the number of commutator bars is
(*a*) 80
(*b*) 20
(*c*) 40
(*d*) 160

10. A 4-pole, 12-slot lap-wound d.c. armature has two coil-sides/slot. Assuming single turn coils and progressive winding, the back pitch would be
(*a*) 5
(*b*) 7
(*c*) 3
(*d*) 6

11. If in the case of a certain d.c. armature, the number of commutator segments is found either one less or more than the number of slots, the armature must be having a simplex ..... winding.
(*a*) wave
(*b*) lap
(*c*) frog leg
(*d*) multielement

12. Lap winding is suitable for ..... current, ... voltage d.c. generators.
(*a*) high, low
(*b*) low, high
(*c*) low, low
(*d*) high, high

13. The series field of a short-shunt d.c. generator is excited by ..... currents.
(*a*) shunt
(*b*) armature
(*c*) load
(*d*) external

14. In a d.c. generator, the generated e.m.f. is directly proportional to the
(*a*) field current
(*b*) pole flux
(*c*) number of armature parallel paths
(*d*) number of dummy coils

15. In a 12-pole triplex lap-wound d.c. armature, each conductor can carry a current of 100 A. The rated current of this armature is ..... ampere.
(*a*) 600
(*b*) 1200
(*c*) 2400
(*d*) 3600

16. The commercial efficiency of a shunt generator is maximum when its variable loss equals ..... loss.
(*a*) constant
(*b*) stray
(*c*) iron
(*d*) friction and windage

17. In small d.c. machines, armature slots are sometimes not made axial but are skewed. Though skewing makes winding a little more difficult, yet it results in
(*a*) quieter operation
(*b*) slight decrease in losses
(*c*) saving of copper
(*d*) both (*a*) and (*b*)

18. The critical resistance of the d.c. generator is the resistance of
(*a*) armature
(*b*) field
(*c*) load
(*d*) brushes **(Grad. I.E.T.E Dec. 1985)**

ANSWERS

1. (*a*) **2.** (*b*) **3.** (*c*) **4.** (*a*) **5.** (*b*) **6.** (*b*) **7.** (*c*) **8.** (*d*) **9.** (*b*) **10.** (*b*)
11. (*a*) **12.** (*a*) **13.** (*c*) **14.** (*b*) **15.** (*d*) **16.** (*a*) **17.** (*d*) **18.** (*b*)

GO To FIRST

3. A 230 V series motor is taking 50 A. Resistance of armature and series field windings is 0.2 Ω and 0.1 Ω respectively. Calculate :

(a) brush voltage (b) back e.m.f.

(c) power wasted in armature (d) mechanical power developed

[(a) **215 V** (b) **205 V** (c) **500 W** (d) **13.74 h.p.**] **(10.25 kW)**

4. Calculate the shaft power of a series motor having the following data; overall efficiency 83.5%, speed 550 r.p.m. when taking 65 A; motor resistance 0.2 Ω, flux per pole 25 mWb, armature winding lap with 1200 conductor.

(15.66 kW)

5. A shunt motor running on no-load takes 5 A at 200 V. The resistance of the field circuit is 150 Ω and of the armature 0.1 Ω. Determine the output and efficiency of motor when the input current is 120 A at 200 V. State any conditions assumed. **(89.8%)**

6. A d.c. shunt motor with interpoles has the following particulars :

Output power ; 8,952 kW, 440-V, armature resistance 1.1 Ω, brush contact drop 2 V, interpole winding resistance 0.4 Ω shunt resistance 650 Ω, resistance in the shunt regulator 50 Ω. Iron and friction losses on full-load 450 W. Calculate the efficiency when taking the full rated current of 24 A.

(85%)

7. A d.c. series motor on full-load takes 50 A from 230 V d.c. mains. The total resistance of the motor is 0.22 Ω. If the iron and friction losses together amount to 5% of the input, calculate the power delivered by the motor shaft. Total voltage drop due to the brush contact is 2 A. **(10.275 kW)**

8. A 2-pole d.c shunt motor operating from a 200 V supply takes a full-load current of 35 A, the no-load current being 2 A. The field resistance is 500 Ω and the armature has a resistance of 0.6 Ω. Calculate the efficiency of the motor on full-load. Take the brush drop as being equal to 1.5 V per brush arm. Neglect temperature rise.

[*Rajiv Gandhi Tech. Univ. Bhopal,2000*] **(82.63%)**

OBJECTIVE TESTS – 29

1. In a d.c. motor, undirectional torque is produced with the help of

(a) brushes (b) commutator

(c) end-plates (d) both (a) and (b)

2. The counter e.m.f. of a d.c. motor

(a) often exceeds the supply voltage

(b) aids the applied voltage

(c) helps in energy conversion

(d) regulates its armature voltage

3. The normal value of the armature resistance of a d.c. motor is

(a) 0.005 (b) 0.5

(c) 10 (d) 100

(*Grad. I.E.T.E. June 1987*)

4. The E_b/V ratio of a d.c. motor is an indication of its

(a) efficiency (b) speed regulation

(c) starting torque (d) Running Torque

(*Grad. I.E.T.E. June 1987*)

5. The mechanical power developed by the armature of a d.c. motor is equal to

(a) armature current multiplied by back e.m.f.

(b) power input minus losses

(c) power output multiplied by efficiency

(d) power output plus iron losses

6. The induced e.m.f. in the armature conductors of a d.c. motor is

(a) sinusoidal (b) trapezoidal

(c) rectangular (d) alternating

7. A d.c. motor can be looked upon as d.c. generator with the power flow

(a) reduced (b) reversed

(c) increased (d) modified

8. In a d.c. motor, the mechanical output power actually comes from

(a) field system

(b) air-gap flux

(c) back e.m.f.

(d) electrical input power

9. The maximum torque of d.c. motors is limited by

(a) commutation (b) heating

(*c*) speed (*d*) armature current

10. Which of the following quantity maintains the same direction whether a d.c. machine runs as a generator or as a motor ?

(*a*) induced e.m.f. (*b*) armature current

(*c*) field current (*d*) supply current

11. Under constant load conditions, the speed of a d.c. motor is affected by

(*a*) field flux (*b*) armature current

(*c*) back e.m.f. (*d*) both (*b*) and (*c*)

12. It is possible to increase the field flux and, at the same time, increase the speed of a d.c. motor provided its ..... is held constant.

(*a*) applied voltage

(*b*) torque

(*c*) Armature circuit resistance

(*d*) armature current

13. The current drawn by a 120 - V d.c. motor of armature resistance 0.5 Ω and back e.m.f. 110 V is ..... ampere.

(*a*) 20 (*b*) 240

(*c*) 220 (*d*) 5

14. The shaft torque of a d.c. motor is less than its armature torque because of ..... losses.

(*a*) copper (*b*) mechanical

(*c*) iron (*d*) rotational

15. A d.c. motor develops a torque of 200 N-m at 25 rps. At 20 rps it will develop a torque of ..... N-m.

(*a*) 200 (*b*) 160

(*c*) 250 (*d*) 128

16. Neglecting saturation, if current taken by a series motor is increased from 10 A to 12 A, the percentage increase in its torque is ..... percent

(*a*) 20 (*b*) 44

(*c*) 30.5 (*d*) 16.6

17. If load on a d.c. shunt motor is increased, its speed is decreased due primarily to

(*a*) increase in its flux

(*b*) decrease in back e.m.f.

(*c*) increase in armature current

(*d*) increase in brush drop

18. If the load current and flux of a d.c. motor are held constant and voltage applied across its armature is increased by 10 per cent, its speed will

(*a*) decrease by about 10 per cent

(*b*) remain unchanged

(*c*) increase by about 10 per cent

(*d*) increase by 20 per cent.

19. If the pole flux of a d.c. motor approaches zero, its speed will

(*a*) approach zero

(*b*) approach infinity

(*c*) no change due to corresponding change in back e.m.f.

(*d*) approach a stable value somewhere between zero and infinity.

20. If the field circuit of a loaded shunt motor is suddenly opened

(*a*) it would race to almost infinite speed

(*b*) it would draw abnormally high armature current

(*c*) circuit breaker or fuse will open the circuit before too much damage is done to the motor

(*d*) torque developed by the motor would be reduced to zero.

21. Which of the following d.c. motor would be suitable for drives requiring high starting torque but only fairly constant speed such as crushers ?

(*a*) shunt (*b*) series

(*c*) compound (*d*) permanent magnet

22. A d.c. shunt motor is found suitable to drive fans because they require

(*a*) small torque at start up

(*b*) large torque at high speeds

(*c*) practically constant voltage

(*d*) both (*a*) and (*b*)

23. Which of the following load would be best driven by a d.c. compound motor ?

(*a*) reciprocating pump

(*b*) centrifugal pump

(*c*) electric locomotive

(*d*) fan

24. As the load is increased, the speed of a d.c. shunt motor

(*a*) increases proportionately

(*b*) remains constant

(*c*) increases slightly

(*d*) reduces slightly

25. Between no-load and full-load, ... motor develops the *least* torque

(*a*) series

(*b*) shunt

(*c*) cumulative compound

(*d*) differential compound

26. The T_d/I_a graph of a d.c. series motor is a
(*a*) parabola from no-load to overload
(*b*) straight line throughout
(*c*) parabola throughout
(*d*) parabola upto full-load and a straight line at overloads.

27. As compared to shunt and compound motors, series motor has the highest torque because of its comparatively ..... at the start.
(*a*) lower armature resistance
(*b*) stronger series field
(*c*) fewer series turns
(*d*) larger armature current

28. Unlike a shunt motor, it is difficult for a series motor to stall under heavy loading because
(*a*) it develops high overload torque
(*b*) its flux remains constant
(*c*) it slows down considerably
(*d*) its back e.m.f. is reduced to almost zero.

29. When load is removed, ... motor will run at the ***highest*** speed.
(*a*) shunt
(*b*) cumulative-compound
(*c*) differential compound
(*d*) series

30. A series motor is best suited for driving
(*a*) lathes
(*b*) cranes and hoists
(*c*) shears and punches
(*d*) machine tools

31. A 220 V shunt motor develops a torque of 54 N-m at armature current of 10 A. The torque produced when the armature current is 20 A, is
(*a*) 54 N-m (*b*) 81 N-m
(*c*) 108 N-m (*d*) None of the above
(Elect. Machines, A.M.I.E. Sec. B, 1993)

32. The d.c. series motor should never be switched on at no load because
(*a*) the field current is zero
(*b*) The machine does not pick up
(*c*) The speed becomes dangerously high
(*d*) It will take too long to accelerate.
(Grad. I.E.T.E. June 1988)

33. A shunt d.c. motor works on a.c. mains
(*a*) unsatisfactorily (*b*) satisfactorily
(*c*) not at all (*d*) none of the above
(Elect. Machines, A.M.I.E. Sec. B, 1993)

34. A 200 V, 10 A motor could be rewound for 100 V, 20 A by using ..... as many turns per coil of wire, having ..... the cross-sectional area.
(*a*) twice, half
(*b*) thrice, one third
(*c*) half, twice
(*d*) four times, one-fourth

ANSWERS

1. (*d*) **2.** (*c*) **3.**(*b*) **4.** (*a*) **5.** (*a*) **6.** (*a*) **7.** (*b*) **8.** (*d*) **9.** (*a*) **10.** (*a*) **11.**(*a*)
12. (*d*) **13.** (*a*) **14.** (*d*) **15.** (*a*) **16.** (*b*) **17.** (*b*) **18.** (*c*) **19.** (*b*) **20.** (*c*) **21.** (*c*) **22.** (*d*)
23. (*a*) **24.** (*d*) **25.** (*a*) **26.** (*d*) **27.** (*b*) **28.** (*a*) **29.** (*d*) **30.** (*b*) **31.** (*c*) **32.** (*c*) **33.** (*a*)
34. (*c*).

GO To FIRST

OBJECTIVE TESTS – 32

1. A transformer transforms
(*a*) frequency
(*b*) voltage
(*c*) current
(*d*) voltage and current.

2. Which of the following is not a basic element of a transformer ?
(*a*) core
(*b*) primary winding
(*c*) secondary winding
(*d*) mutual flux.

3. In an ideal transformer,
(*a*) windings have no resistance
(*b*) core has no losses
(*c*) core has infinite permeability
(*d*) all of the above.

4. 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.

5. Transformer cores are laminated in order to
(*a*) simplify its construction
(*b*) minimise eddy current loss
(*c*) reduce cost
(*d*) reduce hysteresis loss.

6. A transformer having 1000 primary turns is connected to a 250-V a.c. supply. For a secondary voltage of 400 V, the number of secondary turns should be
(*a*) 1600 (*b*) 250
(*c*) 400 (*d*) 1250

7. The primary and secondary induced e.m.fs. E_1 and E_2 in a two-winding transformer are **always**
(*a*) equal in magnitude
(*b*) antiphase with each other
(*c*) in-phase with each other
(*d*) determined by load on transformer secondary.

8. A step-up transformer increases
(*a*) voltage (*b*) current
(*c*) power (*d*) frequency.

9. The primary and secondary windings of an ordinary 2-winding transformer **always** have
(*a*) different number of turns
(*b*) same size of copper wire
(*c*) a common magnetic circuit
(*d*) separate magnetic circuits.

10. In a transformer, the leakage flux of each winding is proportional to the current in that winding because
(*a*) Ohm's law applies to magnetic circuits
(*b*) leakage paths do not saturate
(*c*) the two windings are electrically isolated
(*d*) mutual flux is confined to the core.

11. In a two-winding transformer, the e.m.f. per turn in secondary winding is **always**.....the induced e.m.f. power turn in primary.
(*a*) equal to K times
(*b*) equal to $1/K$ times
(*c*) equal to
(*d*) greater than.

12. In relation to a transformer, the ratio 20 : 1 indicates that
(*a*) there are 20 turns on primary one turn on secondary
(*b*) secondary voltage is 1/20th of primary voltage
(*c*) primary current is 20 times greater than the secondary current.
(*d*) for every 20 turns on primary, there is one turn on secondary.

13. In performing the short circuit test of a transformer
(*a*) high voltage side is usually short circuited
(*b*) low voltage side is usually short circuited
(*c*) any side is short circuited with preference
(*d*) none of the above.
(Elect. Machines, A.M.I.E. Sec. B, 1993)

14. The equivalent resistance of the primary of a transformer having $K = 5$ and $R_1 = 0.1$ ohm when referred to secondary becomes.....ohm.
(*a*) 0.5
(*b*) 0.02
(*c*) 0.004
(*d*) 2.5

15. A transformer has negative voltage regulation when its load power factor is
(*a*) zero
(*b*) unity
(*c*) leading
(*d*) lagging.

16. The primary reason why open-circuit test is performed on the low-voltage winding of the transformer is that it
(*a*) draws sufficiently large on-load current for convenient reading
(*b*) requires least voltage to perform the test
(*c*) needs minimum power input
(*d*) involves less core loss.

17. No-load test on a transformer is carried out to determine
(*a*) copper loss
(*b*) magnetising current
(*c*) magnetising current and no-load loss
(*d*) efficiency of the transformer.

18. The main purpose of performing open-circuit test on a transformer is to measure its
(*a*) Cu loss
(*b*) core loss
(*c*) total loss
(*d*) insulation resistance.

19. During short-circuit test, the iron loss of a transformer is negligible because
(*a*) the entire input is just sufficient to meet Cu losses only
(*b*) flux produced is a small fraction of the normal flux
(*c*) iron core becomes fully saturated
(*d*) supply frequency is held constant.

20. The iron loss of a transformer at 400 Hz is 10 W. Assuming that eddy current and hysteresis losses vary as the square of flux density, the iron loss of the transformer at rated voltage but at 50 Hz would be..... watt.
(*a*) 80 (*b*) 640
(*c*) 1.25 (*d*) 100

21. In operating a 400 Hz transformer at 50 Hz
(*a*) only voltage is reduced in the same proportion as the frequency
(*b*) only kVA rating is reduced in the same proportion as the frequency
(*c*) both voltage and kVA rating are reduced in the same proportion as the frequency
(*d*) none of the above.

22. The voltage applied to the h.v. side of a transformer during short-circuit test is 2% of its rated voltage. The core loss will be.....percent of the rated core loss.
(*a*) 4 (*b*) 0.4
(*c*) 0.25 (*d*) 0.04

23. Transformers are rated in kVA instead of kW because
(*a*) load power factor is often not known
(*b*) kVA is fixed whereas kW depends on load p.f.
(*c*) total transformer loss depends on volt-ampere
(*d*) it has become customary.

24. When a 400-Hz transformer is operated at 50 Hz its kVA rating is
(*a*) raduced to 1/8
(*b*) increased 8 times
(*c*) unaffected
(*d*) increased 64 times.

25. At relatively light loads, transformer efficiency is low because
(*a*) secondary output is low
(*b*) transformer losses are high
(*c*) fixed loss is high in proportion to the output
(*d*) Cu loss is small.

26. A 200 kVA transformer has an iron loss of 1 kW and full-load Cu loss of 2kW. Its load kVA corresponding to maximum efficiency is ..... kVA.
(*a*) 100 (*b*) 141.4
(*c*) 50 (*d*) 200

27. If Cu loss of a transformer at 7/8th full load is 4900 W, then its full-load Cu loss would be .....watt.
(*a*) 5600 (*b*) 6400
(*c*) 375 (*d*) 429

28. 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 Cu loss equals iron loss
(*d*) it runs slightly overload.

29. The output current corresponding to maximum efficiency for a transformer having core loss of 100 W and equivalent resistance referred to secondary of 0.25 Ω is ..... ampere.
(*a*) 20
(*b*) 25
(*c*) 5
(*d*) 400

30. The maximum efficiency of a 100-kVA transformer having iron loss of 900 kW and F.L. Cu loss of 1600 W occurs at ..... kVA.
(*a*) 56.3 (*b*) 133.3
(*c*) 75 (*d*) 177.7

31. The all-day efficiency of a transformer depends primarily on
(*a*) its copper loss
(*b*) the amount of load
(*c*) the duration of load
(*d*) both (*b*) and (*c*).

32. The marked increase in kVA capacity produced by connecting a 2 winding transformer as an autotransfomer is due to
(*a*) increase in turn ratio
(*b*) increase in secondary voltage
(*c*) increase in transformer efficiency
(*d*) establishment of conductive link between primary and secondary.

33. The kVA rating of an ordinary 2-winding transformer is increased when connected as an autotransformer because
(*a*) transformation ratio is increased
(*b*) secondary voltage is increased
(*c*) energy is transferred both inductively and conductivity
(*d*) secondary current is increased.

34. The saving in Cu achieved by converting a 2-winding transformer into an autotransformer is determined by
(*a*) voltage transformation ratio
(*b*) load on the secondary
(*c*) magnetic quality of core material
(*d*) size of the transformer core.

35. An autotransformer having a transformation ratio of 0.8 supplies a load of 3 kW. The power transferred conductively from primary to secondary is.....kW.
(*a*) 0.6 (*b*) 2.4
(*c*) 1.5 (*d*) 0.27

36. The essential condition for parallel opearation of two 1-ϕ transformers is that they should have the same
(*a*) polarity
(*b*) kVA rating
(*c*) voltage ratio
(*d*) percentage impedance.

37. If the impedance triangles of two transformers operating in parallel are not identical in shape and size, the two transformers will
(*a*) share the load unequally
(*b*) get heated unequally
(*c*) have a circulatory secondary current even when unloaded
(*d*) run with different power factors.

38. Two transformers *A* and *B* having equal outputs and voltage ratios but unequal percentage impedances of 4 and 2 are operating in parallel. Transformer *A* will be running over-load by ..... percent.
(*a*) 50 (*b*) 66
(*c*) 33 (*d*) 25

ANSWERS

1. *d* **2.** *d* **3.** *d* **4.** *d* **5.** *b* **6.** *a* **7.** *c* **8.** *a* **9.** *c* **10.** *b* **11.** *c* **12.** *d* **13.** *b* **14.** *d* **15.** *c* **16.** *a* **17.** *c* **18.** *b* **19.** *b* **20.** *b* **21.** *b* **22.** *d* **23.** *c* **24.** *a* **25.** *c* **26.** *b* **27.** *b* **28.** *c* **29.** *a* **30.** *c* **31.** *d* **32.** *d* **33.** *c* **34.** *a* **35.** *b* **36.** *a* **37.** *d* **38.** *c*

GO To FIRST

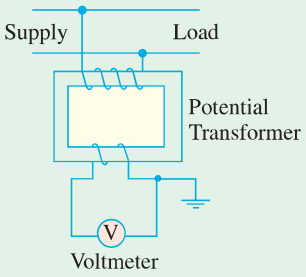

Fig. 33.34

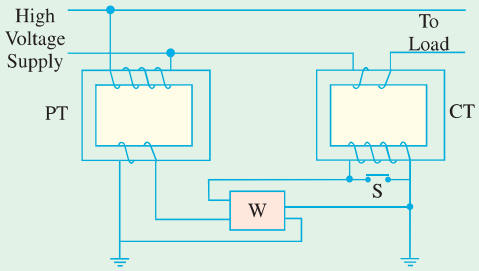

Fig. 33.35

Fig. 33.35 shows the connections of instrument transformers to a wattmeter. While connecting the wattmeter, the relative polarities of the secondary terminals of the transformers with respect to their primary terminals must be known for connections of the instruments.

OBJECTIVE TEST – 33

1. Which of the following connections is best suited for 3-phase, 4-wire service ?
(*a*) Δ – Δ (*b*) Y – Y
(*c*) Δ – Y (*d*) Y – Δ

2. In a three-phase Y-Y transformer connection, neutral is fundamental to the
(*a*) suppression of harmonics
(*b*) passage of unbalanced currents due to unbalanced loads
(*c*) provision of dual electric service
(*d*) balancing of phase voltages with respect to line voltages.

3. As compared to Δ – Δ bank, the capacity of the *V* – *V* bank of transformers is ..... percent.
(*a*) 57.7 (*b*) 66.7
(*c*) 50 (*d*) 86.6

4. If three transformers in a Δ – Δ are delivering their rated load and one transformer is removed, then overload on *each* of the remaining transformers is ..... percent.
(*a*) 66.7 (*b*) 173.2
(*c*) 73.2 (*d*) 58

5. When a V – V system is converted into a Δ – Δ system, increase in capacity of the system is ..... percent.
(*a*) 86.6 (*b*) 66.7
(*c*) 73.2 (*d*) 50

6. For supplying a balanced 3 – ϕ load of 40-kVA, rating of each transformer in V – V bank should be nearly ..... kVA.
(*a*) 20 (*b*) 23
(*c*) 34.6 (*d*) 25

7. When a closed – Δ bank is converted into an open – Δ bank, each of the two remaining transformers supplies ..... percent of the original load.
(*a*) 66.7 (*b*) 57.7
(*c*) 50 (*d*) 73.2

8. If the load p.f. is 0.866, then the average p.f. of the V – V bank is
(*a*) 0.886 (*b*) 0.75
(*c*) 0.51 (*d*) 0.65

9. A T – T connection has higher ratio of utilization that a V – V connection only when
(*a*) identical transformers are used
(*b*) load power factor is leading
(*c*) load power factor is unity
(*d*) non-identical transformers are used.

10. The biggest advantage of T - T connection over the V - V connection for 3-phase power transformation is that it provides
(*a*) a set of balanced voltages under load
(*b*) a true 3-phase, 4-wire system
(*c*) a higher ratio of utilization
(*d*) more voltages.

11. Of the following statements concerning parallel operation of transformers, the one which is **not** correct is
(*a*) transformers must have equal voltage ratings
(*b*) transformers must have same ratio of transformation
(*c*) transformers must be operated at the same frequency
(*d*) transformers must have equal kVA ratings.

12. Statement

An auto-transformer is more efficient in transferring energy from primary to secondary circuit.

Reason

Because it does so both inductively and conductively.

Key

(*a*) statement is false, reason is correct and relevant

(*b*) statement is correct, reason is correct but irrelevant

(*c*) both statement and reason are correct and are connected to each other as cause and effect

(*d*) both statement and reason are false.

13. Out of the following given choices for poly phase transformer connections which one will you select for three-to-two phase conversion ?

(*a*) Scott (*b*) star/star

(*c*) double Scott (*d*) star/double-delta

14. A T – T transformer cannot be paralleled with ..... transformer.

(*a*) V – V (*b*) Y – Δ

(*c*) Y – Y (*d*) Δ – Δ

15. Instrument transformers are used on a.c. circuits for extending the range of

(*a*) ammeters (*b*) voltmeters

(*c*) wattmeters (*d*) all of the above.

16. Before removing the ammeter from a current transformer, its secondary must be short-circuited in order to avoid

(*a*) excessive heating of the core

(*b*) high secondary e.m.f.

(*c*) increase in iron losses

(*d*) all of the above.

ANSWERS

1. *c* **2.** *a* **3.** *a* **4.** *c* **5.** *c* **6.** *b* **7.** *b* **8.** *b* **9.** *d* **10.** *b* **11.** *d* **12.** *c* **13.** *a* **14.** *b* **15.** *d* **16.** *d*

GO To FIRST

Now, $I_2' = \dfrac{V_1}{\sqrt{(R_1 + R_2')^2 + (X_1 + X_2')^2}} = \dfrac{400/\sqrt{3}}{\sqrt{(0.4 + 0.6)^2 + (1 + 1)^2}} = 103.3$ A

$\therefore \quad T_{g\text{-}max} = \dfrac{3 \times 103.3^2 \times 1/0.29}{2\pi \times 1500/60} = \mathbf{351\ N - m}$ ... assuming $N_S = 1500$ r.p.m.

(iii) The equivalent circuit for one phase for a slip of 0.05 is shown in Fig. 32.59 (*b*).

$I_2' = 231/[(20 + 0.4) + j\,2] = 11.2 - j\,1.1$

$I_0 = 231/(10 + j\,50) = 0.89 - j\,4.4$

$I_1 = I_0 + I_2' = 12.09 - j\,5.5 = 13.28 \angle -24.4°$; p.f. = cos 24.4° = **0.91 (lag)**

Tutorial Problem No. 34.4.

1. A 3-phase, 115-volt induction motor has the following constants : $R_2 = 0.07\ \Omega$; $R_2' = 0.08\ \Omega$, $X_1 = 0.4\ \Omega$ and $X_2' = 0.2\ \Omega$. All the values are for one phase only. At which slip the gross power output will be maximum and the value of the gross power output ? **[11.4% ; 8.6 kW]**
2. A 3-phase, 400-V, Y-connected induction motor has an equivalent *T*-circuit consisting of $R_1 = 1\ \Omega$, $X_1 = 2\ \Omega$, equivalent rotor values are $R_2' = 1.2\ \Omega$, $X_2' = 1.5\ \Omega$. The exciting branch has an impedance of $(4 + j\,40)\ \Omega$. If slip is 5% find (*i*) current (*ii*) efficiency (*iii*) power factor (*iv*) output. Assume friction loss to be 250 W. ***[(i) 10.8 A (ii) 81% (iii) 0.82 (iv) 5 kW]***
3. A 50 HP, 440 Volt, 3-phase, 50 Hz Induction motor with star-connected stator winding gave the following test results:

   (*i*) No load test: Applied line voltage 440 V, line current 24 A, wattmeter reading 5150 and 3350 watts.

   (*ii*) Blocked rotor test: applied line voltage 33.6 volt, line current 65 A, wattmeter reading 2150 and 766 watts.

   Calculate the parameters of the equivalent circuit.

   [Rajiv Gandhi Technical University, Bhopal, 2000]

   [(*i*) Shunt branch : $R_o = 107.6$ ohms, $X_m = 10.60$ ohms (*ii*) Series branch : $r = 0.23$ ohm, $x = 0.19$ ohm]

OBJECTIVE TESTS – 34

1. Regarding skewing of motor bars in a squirrel-cage induction motor, (SCIM) which statement is false ?
   (*a*) it prevents cogging
   (*b*) it increases starting torque
   (*c*) it produces more uniform torque
   (*d*) it reduces motor 'hum' during its operation.
2. The principle of operation of a 3-phase. Induction motor is most similar to that of a
   (*a*) synchronous motor
   (*b*) repulsion-start induction motor
   (*c*) transformer with a shorted secondary
   (*d*) capacitor-start, induction-run motor.
3. The magnetising current drawn by transformers and induction motors is the cause of their .....power factor.
   (*a*) zero (*b*) unity
   (c) lagging (*d*) leading.
4. The effect of increasing the length of air-gap in an induction motor will be to increase the
   (*a*) power factor
   (*b*) speed
   (*c*) magnetising current
   (*d*) air-gap flux.

   (Power App-II, Delhi Univ. Jan. 1987)
5. In a 3-phase induction motor, the relative speed of stator flux with respect to .....is zero.
   (*a*) stator winding (*b*) rotor
   (c) rotor flux (*d*) space.
6. An eight-pole wound rotor induction motor operating on 60 Hz supply is driven at 1800 r.p.m. by a prime mover in the opposite direction of revolving magnetic field. The frequency of rotor current is
   (*a*) 60 Hz (*b*) 120 Hz
   (c) 180 Hz (*d*) none of the above.

(Elect. Machines, A.M.I.E. Sec. B, 1993)

7. A 3-phase, 4-pole, 50-Hz induction motor runs at a speed of 1440 r.p.m. The rotating field produced by the rotor rotates at a speed of .....r.p.m. with respect to the rotor.
(*a*) 1500 (*b*) 1440
(c) 60 (*d*) 0.

8. In a 3-ϕ induction motor, the rotor field rotates at synchronous speed with respect to
(*a*) stator (*b*) rotor
(*c*) stator flux (*d*) none of the above.

9. Irrespective of the supply frequency, the torque developed by a SCIM is the same whenever ..... is the same.
(*a*) supply voltage (*b*) external load
(*c*) rotor resistance (*d*) slip speed.

10. In the case of a 3-ϕ induction motor having N_s = 1500 rpm and running with s = 0.04
(*a*) revolving speed of the stator flux is space is .....rpm
(*b*) rotor speed is .....rpm
(*c*) speed of rotor flux relative to the rotor is .....rpm
(*d*) speed of the rotor flux with respect to the stator is .....rpm.

11. The number of stator poles produced in the rotating magnetic field of a 3-ϕ induction motor having 3 slots per pole per phase is
(*a*) 3 (*b*) 6
(c) 2 (*d*) 12

12. The power factor of a squirrel-cage induction motor is
(*a*) low at light loads only
(*b*) low at heavy loads only
(*c*) low at light and heavy loads both
(*d*) low at rated load only.

(Elect. Machines, A.M.I.E. Sec.B, 1993)

13. Which of the following rotor quantity in a SCIM does NOT depend on its slip ?
(*a*) reactance (*b*) speed
(*c*) induced emf (*d*) frequency.

14. A 6-pole, 50-Hz, 3-ϕ induction motor is running at 950 rpm and has rotor Cu loss of 5 kW. Its rotor input is .....kW.
(*a*) 100 (b) 10
(c) 95 (*d*) 5.3.

15. The efficiency of a 3-phase induction motor is approximately proportional to
(*a*) (1– s) (*b*) s
(*c*) N (*d*) N_s.

16. A 6-pole, 50-Hz, 3-ϕ induction motor has a full-load speed of 950 rpm. At half-load, its speed would be .....rpm.
(*a*) 475 (*b*) 500
(*c*) 975 (*d*) 1000

17. If rotor input of a SCIM running with a slip of 10% is 100 kW, gross power developed by its rotor is ..... kW.
(*a*) 10 (*b*) 90
(*c*) 99 (*d*) 80

18. Pull-out torque of a SCIM occurs at that value of slip where rotor power factor equals
(*a*) unity (*b*) 0.707
(*c*) 0.866 (*d*) 0.5

19. Fill in the blanks.
When load is placed on a 3-phase induction motor, its
(*i*) speed .....
(*ii*) slip .....
(*iii*) rotor induced emf .....
(*iv*) rotor current .....
(*v*) rotor torque .....
(*vi*) rotor continues to rotate at that value of slip at which developed torque equals ..... torque.

20. When applied rated voltage per phase is reduced by one-half, the starting torque of a SCIM becomes ..... of the starting torque with full voltage.
(*a*) 1/2 (*b*) 1/4
(*c*) $1/\sqrt{2}$ (*d*) $\sqrt{3}/2$

21. If maximum torque of an induction motor is 200 kg-m at a slip of 12%, the torque at 6% slip would be ..... kg-m.
(*a*) 100 (*b*) 160
(*c*) 50 (*d*) 40

22. The fractional slip of an induction motor is the ratio
(*a*) rotor Cu loss/rotor input
(*b*) stator Cu loss/stator input
(*c*) rotor Cu loss/rotor output
(*d*) rotor Cu loss/stator Cu loss

23. The torque developed by a 3-phase induction motor depends on the following three factors:
(*a*) speed, frequency, number of poles
(*b*) voltage, current and stator impedance
(*c*) synchronous speed, rotor speed and frequency

(*d*) rotor emf, rotor current and rotor p.f.

24. If the stator voltage and frequency of an induction motor are reduced proportionately, its
(*a*) locked rotor current is reduced
(*b*) torque developed is increased
(*c*) magnetising current is decreased
(*d*) both (*a*) and (*b*)

25. The efficiency and p.f. of a SCIM increases in proportion to its
(*a*) speed (*b*) mechanical load
(*c*) voltage (*d*) rotor torque

26. A SCIM runs at ***constant*** speed only so long as
(*a*) torque developed by it remains constant
(*b*) its supply voltage remains constant
(*c*) its torque exactly equals the mechanical load
(*d*) stator flux remains constant

27. The synchronous speed of a linear induction motor does NOT depend on
(*a*) width of pole pitch
(*b*) number of poles
(*c*) supply frequency
(*d*) any of the above

28. Thrust developed by a linear induction motor depends on
(*a*) synchronous speed
(*b*) rotor input
(*c*) number of poles
(*d*) both (*a*) and (*b*)

ANSWERS

1. *b* **2.** *c* **3.** *c* **4.** *c* **5.** *c* **6.** *c* **7.** *c* **8.** *a* **9.** *d* **10.** (*i*) 1500 (*ii*) 1440 (*iii*) 60 (*iv*) 1500 **11.** *b* **12.** *a* **13.** *b* **14.** *a* **15.** *a* **16.** *c* **17.** *b* **18.** *b* **19.** (*i*) decreases (*ii*) increases (*iii*) increases (*iv*) increases (*v*) increases (*vi*) applied **20.** *b* **21.** *b* **22.** *a* **23.** *d* **24.** *d* **25.** *b* **26.** *c* **27.** *b* **28.** *d*

Q.9. What could be the reasons if a split-phase motor fails to start and hums loudly ?

Ans. It could be due to the starting winding being open or grounded or burnt out.

Q.10. What could be the reasons if a split-phase motor runs too slow ?

Ans. Any one of the following factors could be responsible :

1. wrong supply voltage and frequency
2. overload
3. grounded starting and running windings
4. short-circuited or open winding in field circuit.

OBJECTIVE TESTS – 36

1. The starting winding of a single-phase motor is placed in the
(*a*) rotor (*b*) stator
(*c*) armature (*d*) field.

2. One of the characteristics of a single- phase motor is that it
(*a*) is self-starting
(*b*) is not self-starting
(*c*) requires only one winding
(*d*) can rotate in one direction only.

3. After the starting winding of a single- phase induction motor is disconnected from supply, it continues to run only on .....winding.
(*a*) rotor (*b*) compensating
(*c*) field (*d*) running

4. If starting winding of a single-phase induction motor is left in the circuit, it will
(*a*) draw excessive current and overheat
(*b*) run slower
(*c*) run faster
(*d*) spark at light loads.

5. The direction of rotation of a single-phase motor can be reversed by
(*a*) reversing connections of both windings
(*b*) reversing connections of starting winding
(*c*) using a reversing switch
(*d*) reversing supply connections.

6. If a single-phase induction motor runs slower than normal, the more likely defect is
(*a*) improper fuses
(*b*) shorted running winding
(*c*) open starting winding
(*d*) worn bearings.

7. The capacitor in a capacitor-start induction- run ac motor is connected in series with ..... winding.
(*a*) starting (*b*) running
(*c*) squirrel-cage (*d*) compensating

8. A permanent-split single-phase capacitor motor does not have
(*a*) centrifugal switch
(*b*) starting winding
(*c*) squirrel-cage rotor
(*d*) high power factor.

9. The starting torque of a capacitor-start induction-run motor is directly related to the angle α between its two winding currents by the relation
(*a*) cos α (*b*) sin α
(*c*) tan α (*d*) sin $\alpha/2$.

10. In a two-value capacitor motor, the capacitor used for running purposes is a/an
(*a*) dry-type ac electrolytic capacitor
(*b*) paper-spaced oil-filled type
(*c*) air-capacitor
(*d*) ceramic type.

11. If the centrifugal switch of a two-value capacitor motor using two capacitors fails to open, then
(*a*) electrolytic capacitor will, in all probability, suffer breakdown
(*b*) motor will not carry the load
(*c*) motor will draw excessively high current
(*d*) motor will not come upto the rated speed.

12. Each of the following statements regarding a shaded-pole motor is true **except**
(*a*) its direction of rotation is from un- shaded to shaded portion of the poles
(*b*) it has very poor efficiency
(*c*) it has very poor p.f.
(*d*) it has high starting torque.

13. Compensating winding is employed in an ac series motor in order to

(*a*) compensate for decrease in field flux
(*b*) increase the total torque
(*c*) reduce the sparking at brushes
(*d*) reduce effects of armature reaction.

14. A universal motor is one which
(*a*) is available universally
(*b*) can be marketed internationally
(*c*) can be operated either on dc or ac supply
(d) runs at dangerously high speed on no-load.

15. In a single-phase series motor the main purpose of inductively-wound compensating winding is to reduce the
(*a*) reactance emf of commutation
(*b*) rotational emf of commutation
(*c*) transformer emf of commutation
(*d*) none of the above.
(Power App.-II, Delhi Univ. Jan. 1987)

16. A repulsion motor is equipped with
(*a*) a commutator (*b*) slip-rings
(*c*) a repeller
(*d*) neither (*a*) nor (*b*).

17. A repulsion-start induction-run single- phase motor runs as an induction motor only when
(*a*) brushes are shifted to neutral plane
(*b*) short-circuiter is disconnected
(*c*) commutator segments are short- circuited
(*d*) stator winding is reversed.

18. If a dc series motor is operated on ac supply, it will
(*a*) have poor efficiency
(*b*) have poor power factor
(*c*) spark excessively
(*d*) all of the above
(*e*) none of the above.

19. An outstanding feature of a universal motor is its
(*a*) best performance at 50 Hz supply
(*b*) slow speed at all loads
(*c*) excellent performance on dc. supply
(*d*) highest output kW/kg ratio.

20. The direction of rotation of a hysteresis motor is determined by the
(*a*) retentivity of the rotor material
(*b*) amount of hysteresis loss
(*c*) permeability of rotor material
(*d*) position of shaded pole with respect to the main pole.

21. Speed of the universal motor is
(*a*) dependent on frequency of supply
(*b*) proportional to frequency of supply
(*c*) independent of frequency of supply
(*d*) none of the above.
(Elect. Machines, A.M.I.E. Sec. B, 1993)

22. In the shaded pole squirrel cage induction motor the flux in the shaded part always
(*a*) leads the flux in the unshaded pole segment
(*b*) is in phase with the flux in the unshaded pole segment
(*c*) lags the flux in the unshaded pole segment
(*d*) none of the above.
(Elect. Machines, A.M.I.E. Sec. B, 1993)

23. Which of the following motor is an interesting example of beneficially utilizing a phenomenon that is often considered undesirable ?
(*a*) hysteresis motor
(*b*) reluctance motor
(*c*) stepper motor
(*d*) shaded-pole motor.

24. Usually, large motors are more efficient than small ones. The efficiency of the tiny motor used in a wrist watch is approximately..... per cent.
(*a*) 1
(*b*) 10
(*c*) 50
(*d*) 80

ANSWERS

1. *b* **2.** *b* **3.** *d* **4.** *a* **5.** *b* **6.** *d* **7.** *a* **8.** *a* **9.** *b* **10.** *b* **11.** *a* **12.** *d* **13.** *d* **14.** *c* **15.** *d* **16.** *a* **17.** *c* **18.** *d* **19.** *d* **20.** *d* **21.** *a* **22.** *c* **23.** *a* **24.** *a*

Q. 9. How is a direct-connected exciter arranged in an alternator ?

Ans. The armature of the exciter is mounted on the shaft of the alternator close to the spider hub. In some cases, it is mounted at a distance sufficient to permit a pedestal and bearing to be placed between the exciter and the hub.

Q. 10. Any advantage of a direct-connected exciter ?

Ans. Yes, economy of space.

Q. 11. Any disadvantage ?

Ans. The exciter has to run at the same speed as the alternator which is slower than desirable. Hence, it must be larger for a given output than the gear-driven type, because it can be run at high speed and so made proportionately smaller.

OBJECTIVE TESTS – 37

1. The frequency of voltage generated by an alternator having 4-poles and rotating at 1800 r.p.m. is .....hertz.
(*a*) 60 (*b*) 7200
(*c*) 120 (*d*) 450.

2. A 50-Hz alternator will run at the greatest possible speed if it is wound for ..... poles.
(*a*) 8 (*b*) 6
(*c*) 4 (*d*) 2.

3. The main disadvantage of using short-pitch winding in alterators is that it
(*a*) reduces harmonics in the generated voltage
(*b*) reduces the total voltage around the armature coils
(*c*) produces asymmetry in the three phase windings
(*d*) increases Cu of end connections.

4. Three-phase alternators are invariably Y-connected because
(*a*) magnetic losses are minimised
(*b*) less turns of wire are required
(*c*) smaller conductors can be used
(*d*) higher terminal voltage is obtained.

5. The winding of a 4-pole alternator having 36 slots and a coil span of 1 to 8 is short-pitched by ..... degrees.
(*a*) 140 (*b*) 80
(*c*) 20 (*d*) 40.

6. If an alternator winding has a fractional pitch of 5/6, the coil span is ..... degrees.
(*a*) 300 (*b*) 150
(*c*) 30 (*d*) 60.

7. The harmonic which would be totally eliminated from the alternator e.m.f. using a fractional pitch of 4/5 is
(*a*) 3rd (*b*) 7th
(*c*) 5th (*d*) 9th.

8. For eliminating 7th harmonic from the e.m.f. wave of an alternator, the fractional-pitch must be
(*a*) 2/3 (*b*) 5/6
(*c*) 7/8 (*d*) 6/7.

9. If, in an alternator, chording angle for fundamental flux wave is α, its value for 5th harmonic is
(*a*) 5α (*b*) $\alpha/5$
(*c*) 25α (*d*) $\alpha/25$.

10. Regarding distribution factor of an armature winding of an alternator which statement is false?
(*a*) it decreases as the distribution of coils (slots/pole) increases
(*b*) higher its value, higher the induced e.m.f. per phase
(*c*) it is not affected by the type of winding either lap, or wave
(*d*) it is not affected by the number of turns per coil.

11. When speed of an alternator is changed from 3600 r.p.m. to 1800 r.p.m., the generated e.m.f./phases will become
(*a*) one-half (*b*) twice
(*c*) four times (*d*) one-fourth.

12. The magnitude of the three voltage drops in an alternator due to armature resistance, leakage reactance and armature reaction is solely determined by
(*a*) load current, I_a

(*b*) p.f. of the load
(*c*) whether it is a lagging or leading p.f. load
(*d*) field construction of the alternator.

13. Armature reaction in an alternator primarily affects
(*a*) rotor speed
(*b*) terminal voltage per phase
(*c*) frequency of armature current
(*d*) generated voltage per phase.

14. Under no-load condition, power drawn by the prime mover of an alternator goes to
(*a*) produce induced e.m.f. in armature winding
(*b*) meet no-load losses
(*c*) produce power in the armature
(*d*) meet Cu losses both in armature and rotor windings.

15. As load p.f. of an alternator becomes more leading, the value of generated voltage required to give rated terminal voltage
(*a*) increases
(*b*) remains unchanged
(*c*) decreases
(*d*) varies with rotor speed.

16. With a load p.f. of unity, the effect of armature reaction on the main-field flux of an alternator is
(*a*) distortional (*b*) magnetising
(*c*) demagnetising (*d*) nominal.

17. At lagging loads, armature reaction in an alternator is
(*a*) cross-magnetising (*b*) demagnetising
(*c*) non-effective (*d*) magnetising.

18. At leading p.f., the armature flux in an alternator ..... the rotor flux.
(*a*) opposes (*b*) aids
(*c*) distorts (*d*) does not affect.

19. The voltage regulation of an alternator having 0.75 leading p.f. load, no-load induced e.m.f. of 2400V and rated terminal voltage of 3000V is ..... percent.
(*a*) 20 (*b*) – 20
(*c*) 150 (*d*) – 26.7

20. If, in a 3-ϕ alternator, a field current of 50A produces a full-load armature current of 200 A on short-circuit and 1730 V on open circuit, then its synchronous impedance is ..... ohm.
(*a*) 8.66 (*b*) 4
(*c*) 5 (*d*) 34.6

21. The power factor of an alternator is determined by its
(*a*) speed
(*b*) load
(*c*) excitation
(*d*) prime mover.

22. For proper parallel operation, a.c. polyphase alternators must have the same
(*a*) speed (*b*) voltage rating
(*c*) kVA rating (*d*) excitation.

23. Of the following conditions, the one which does not have to be met by alternators working in parallel is
(*a*) terminal voltage of each machine must be the same
(*b*) the machines must have the same phase rotation
(*c*) the machines must operate at the same frequency
(*d*) the machines must have equal ratings.

24. After wiring up two 3-ϕ alternators, you checked their frequency and voltage and found them to be equal. Before connecting them in parallel, you would
(*a*) check turbine speed
(*b*) check phase rotation
(*c*) lubricate everything
(*d*) check steam pressure.

25. Zero power factor method of an alternator is used to find its
(*a*) efficiency
(*b*) voltage regulation
(*c*) armature resistance
(*d*) synchronous impedance.

26. Some engineers prefer `lamps bright' synchronization to 'lamps dark' synchronization because
(*a*) brightness of lamps can be judged easily
(*b*) it gives sharper and more accurate synchronization
(*c*) flicker is more pronounced
(*d*) it can be performed quickly.

27. It is never advisable to connect a stationary alternator to live bus-bars because it
(*a*) is likely to run as synchronous motor
(*b*) will get short-circuited
(*c*) will decrease bus-bar voltage though momentarily
(*d*) will disturb generated e.m.fs. of other alternators connected in parallel.

28. Two identical alternators are running in parallel and carry equal loads. If excitation of one alternator is increased without changing its steam supply, then
(*a*) it will keep supplying almost the same load
(*b*) kVAR supplied by it would decrease
(*c*) its p.f. will increase
(*d*) kVA supplied by it would decrease.

29. Keeping its excitation constant, if steam supply of an alternator running in parallel with another identical alternator is increased, then
(*a*) it would over-run the other alternator
(*b*) its rotor will fall back in phase with respect to the other machine
(*c*) it will supply greater portion of the load
(*d*) its power factor would be decreased.

30. The load sharing between two steam-driven alternators operating in parallel may be adjusted by varying the
(*a*) field strengths of the alternators
(*b*) power factors of the alternators
(*c*) steam supply to their prime movers
(*d*) speed of the alternators.

31. Squirrel-cage bars placed in the rotor pole faces of an alternator help reduce hunting
(*a*) above synchronous speed only
(*b*) below synchronous speed only
(*c*) above and below synchronous speeds both
(*d*) none of the above.
(Elect. Machines, A.M.I.E. Sec. B, 1993)

32. For a machine on infinite bus active power can be varied by
(*a*) changing field excitation
(*b*) changing of prime cover speed
(*c*) both (*a*) and (*b*) above
(*d*) none of the above .
(Elect. Machines, A.M.I.E. Sec. B, 1993)

ANSWERS

1. *a*	**2.** *d*	**3.** *b*	**4.** *d*	**5.** *d*	**6.** *b*	**7.** *c*	**8.** *d*	**9.** *a*	**10.** *b*	**11.** *a*
12. *a*	**13.** *d*	**14.** *b*	**15.** *c*	**16.** *a*	**17.** *d*	**18.** *b*	**19.** *b*	**20.** *c*	**21.** *b*	**22.** *b*
23. *d*	**24.** *b*	**25.** *b*	**26.** *b*	**27.** *b*	**28.** *a*	**29.** *c*	**30.** *c.*	**31.** *c*	**32.** *b*	