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GATE last 10-year questions

Subject: - Electrical Machine

2020

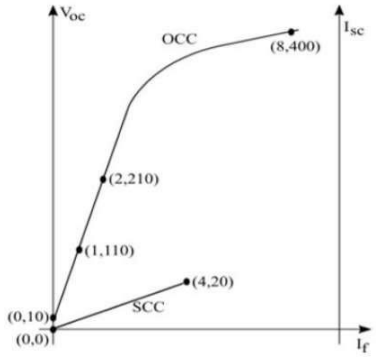
1. A three-phase, 50 Hz, 4-pole induction motor runs at no-load with a slip of 1 %. With full load, the slip increases to 5 %. The % speed regulation of the motor (rounded off to 2 decimal places) is _____.

2. A single-phase, 4 kVA, 200 V/100 V, 50 Hz transformer with laminated CRGO steel core has rated no-load loss of 450 W. When the high-voltage winding is excited with 160 V, 40 Hz sinusoidal ac supply, the no-load losses are found to be 320 W. When the high-voltage winding of the same transformer is supplied from a 100 V, 25 Hz sinusoidal ac source, the no-load losses will be _____ W (rounded off to 2 decimal places).

3. A 250 V dc shunt motor has an armature resistance of 0.2 Ω and a field resistance of 100 Ω. When the motor is operated on no-load at rated voltage, it draws an armature current of 5 A and runs at 1200 rpm. When a load is coupled to the motor, it draws total line current of 50 A at rated voltage, with a 5 % reduction in the air-gap flux due to armature reaction. Voltage drop across the brushes can be taken as 1 V per brush under all operating conditions. The speed of the motor, in rpm, under this loaded condition, is closest to:

(A) 1200 (B) 1000 (C) 1220 (D) 900

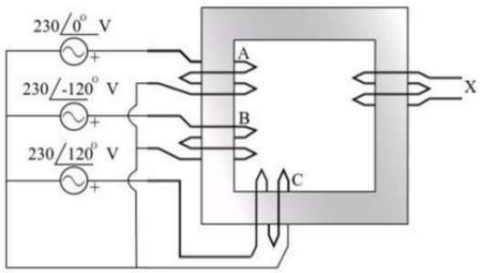
4. The figure below shows the per-phase Open Circuit Characteristics (measured in V) and Short Circuit Characteristics (measured in A) of a 14 kVA, 400 V, 50 Hz, 4-pole, 3-phase, delta connected alternator, driven at 1500 rpm. The field current, I_f is measured in A. Readings taken are marked as respective (x, y) coordinates in the figure. Ratio of the unsaturated and saturated synchronous impedances $(Z_{s(unsat)}/Z_{s(sat)})$ of the alternator is closest to:



(A) 2.100
(B) 2.025
(C) 2.000
(D) 1.000

5. A cylindrical rotor synchronous generator with constant real power output and constant terminal voltage is supplying 100 A current to a 0.9 lagging power factor load. An ideal reactor is now connected in parallel with the load, as a result of which the total lagging reactive power requirement of the load is twice the previous value while the real power remains unchanged. The armature current is now _____ A (rounded off to 2 decimal places).

6. Windings 'A', 'B' and 'C' have 20 turns each and are wound on the same iron core as shown, along with winding 'X' which has 2 turns. The figure shows the sense (clockwise/anti-clockwise) of each of the windings only and does not reflect the exact number of turns. If windings 'A', 'B' and 'C' are supplied with balanced 3-phase voltages at 50 Hz and there is no core saturation, the no-load RMS voltage (in V, rounded off to 2 decimal places) across winding 'X' is _____.



7. A cylindrical rotor synchronous generator has steady state synchronous reactance of 0.7 pu and subtransient reactance of 0.2 pu. It is operating at $(1 + j0)$ pu terminal voltage with an internal emf of $(1 + j0.7)$ pu. Following a three-phase solid short circuit fault at the terminal of the generator, the magnitude of the subtransient internal emf (rounded off to 2 decimal places) is _____ pu.

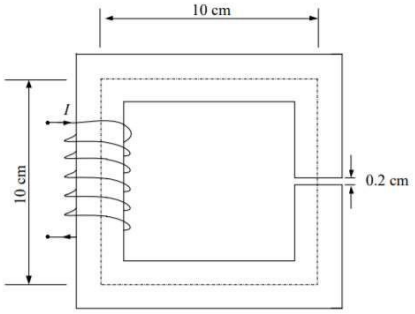
2019

1. A 5 kVA, 50 V/100 V, single-phase transformer has a secondary terminal voltage of 95 V when loaded. The regulation of the transformer is
   (A) 4.5% (B) 9% (C) 5% (D) 1%

2. The parameter of an equivalent circuit of a three-phase induction motor affected by reducing the rms value of the supply voltage at the rated frequency is
   (A) rotor resistance
   (B) rotor leakage reactance
   (C) magnetizing reactance
   (D) stator resistance

3. A three-phase synchronous motor draws 200 A from the line at unity power factor at rated load. Considering the same line voltage and load, the line current at a power factor of 0.5 leading is
   (A) 100 A (B) 200 A (C) 300 A (D) 400 A

4. The magnetic circuit shown below has uniform cross-sectional area and air gap of 0.2 cm. The mean path length of the core is 40 cm. Assume that leakage and fringing fluxes are negligible. When the core relative permeability is assumed to be infinite, the magnetic flux density computed in the air gap is 1 tesla. With same Ampere-turns, if the core relative permeability is assumed to be 1000 (linear), the flux density in tesla (round off to three decimal places) calculated in the air gap is _____.



5. A single-phase transformer of rating 25 kVA, supplies a 12 kW load at power factor of 0.6 lagging. The additional load at unity power factor in kW (round off to two decimal places) that may be added before this transformer exceeds its rated kVA is _____.

6. A 220 V DC shunt motor takes 3 A at no-load. It draws 25 A when running at full-load at 1500 rpm. The armature and shunt resistances are 0.5 Ω and 220 Ω, respectively. The no-load speed in rpm (round off to two decimal places) is _____.

7. A delta-connected, 3.7 kW, 400 V(line), three-phase, 4-pole, 50-Hz squirrel-cage induction motor has the following equivalent circuit parameters per phase referred to the stator: $R_1 = 5.39\ \Omega$, $R_2 = 5.72\ \Omega$, $X_1 = X_2 = 8.22\ \Omega$. Neglect shunt branch in the equivalent circuit. The starting line current in amperes (round off to two decimal places) when it is connected to a 100 V (line), 10 Hz, three-phase AC source is _____ .

8. A 220 V (line), three-phase, Y-connected, synchronous motor has a synchronous impedance of $(0.25 + j2.5)\ \Omega$/phase. The motor draws the rated current of 10 A at 0.8 pf leading. The rms value of line-to-line internal voltage in volts (round off to two decimal places) is _____.

2018

1. A single-phase 100 kVA, 1000 V / 100 V, 50 Hz transformer has a voltage drop of 5% across its series impedance at full load. Of this, 3% is due to resistance. The percentage regulation of the transformer at full load with 0.8 lagging power factor is

   ○ (A) 4.8 ○ (B) 6.8 ○ (C) 8.8 ○ (D) 10.8

2. In a salient pole synchronous motor, the developed reluctance torque attains the maximum value when the load angle in electrical degrees is

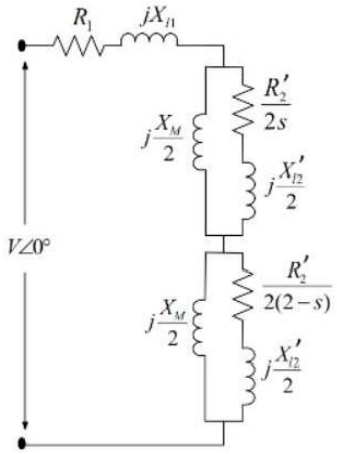
   ○ (A) 0 ○ (B) 45 ○ (C) 60 ○ (D) 90

3. A separately excited dc motor has an armature resistance $R_a = 0.05\ \Omega$. The field excitation is kept constant. At an armature voltage of 100 V, the motor produces a torque of 500 Nm at zero speed. Neglecting all mechanical losses, the no-load speed of the motor (in radian/s) for an armature voltage of 150 V is ____ (up to 2 decimal places).

4. A 3-phase $900\ \text{kVA},\ 3\ \text{kV}/\sqrt{3}\ \text{kV}(\triangle/\text{Y}),$ 50 Hz transformer has primary (high voltage side) resistance per phase of $0.3\ \Omega$and secondary (low voltage side) resistance per phase of $0.02\ \Omega$. Iron loss of the transformer is 10 kW. The full load % efficiency of the transformer operated at unity power factor is _____ (up to 2 decimal places).

5. A 200 V DC series motor, when operating from rated voltage while driving a certain load, draws 10 A current and runs at 1000 r.p.m. The total series resistance is $1\ \Omega$. The magnetic circuit is assumed to be linear. At the same supply voltage, the load torque is increased by 44%. The speed of the motor in r.p.m. (rounded to the nearest integer) is _____ .

8. The equivalent circuit of a single phase induction motor is shown in the figure, where the parameters are $R_1 = R_2' = X_{l1} = X_{l2}' = 12\ \Omega, X_M = 240\ \Omega$ and s is the slip. At no-load, the motor speed can be approximated to be the synchronous speed. The no-load lagging power factor of the motor is_____ (up to 3 decimal places).



2017

1. A 4 pole induction machine is working as an induction generator. The generator supply frequency is 60 Hz. The rotor current frequency is 5 Hz. The mechanical speed of the rotor in RPM is

○ (A) 1350 ○ (B) 1650 ○ (C) 1950 ○ (D) 2250

2. A three-phase, 50 Hz, star-connected cylindrical-rotor synchronous machine is running as a motor. The machine is operated from a 6.6 kV grid and draw current at unity power factor (UPF). The synchronous reactance of the motor is 30 Ω per phase. The load angle is 30°. The power delivered to the motor in kW is_____. (Give the answer up to two decimal phase).

3. A 375 W, 230 V, 50 Hz, capacitor start single-phase indication motor has the following constants for the main and auxiliary windings (at starting): $Z_m = (12.50 + j15.75)\Omega$(main windings), $Z_\alpha = (24.50 + j12.75)\Omega$ (auxiliary winding). Neglecting the magnetizing branch, the value of the capacitance (in μF) to be added in series with the auxiliary winding to obtain maximum torque at starting is _____.

4. Two parallel connected, three-phase, 50Hz, 11 kV, star-connected synchronous machine A and B, are operating as synchronous condensers. They together supply 50 MVAR to a 11 kV grid. Current supplied by both the machines are equal. Synchronous reactances of machine A and machine B are 1Ω and 3Ω , respectively. Assuming the magnetic circuit to be linear, the ratio of excitation current of machine A to that of machine B is _____. (Give the answer up to two decimal places.)

5. A 220 V DC series motor runs drawing a current of 30 A from the supply. Armature and field circuit resistance are 0.4Ω and 0.1Ω, respectively. The load torque varies as the square of the speed. The flux in the motor may be taken as being proportional to the armature current. To reduce the speed of the motor by 50%, the resistance in ohms that should be added in series with the armature is _____ . (Give the answer up to two decimal places.)

6. A three-phase, three winding $\triangle/\triangle/Y\ (1.1\ kV/6.6\ kV/400\ V)$ transformer is energized from AC mains at the 1.1 kV side. It supplies 900 kVA load at 0.8 power factor lag from the 6.6 kV winding and 300 kVA load at 0.6 power factor lag from the 400 V winding. The RMS line current in ampere drawn by the 1.1 kV winding from the mains is _____ . (Give the answer up to two decimal places.)

7. A separately excited DC generator supplies 150 A to a 145 V DC grid. The generator is running at 800 RPM. The armature resistance of the generator is 0.1Ω. If the speed of the generator is increased to 1000 RPM, the current in amperes supplied by the generator to the DC grid is _____. (Give the answer up to two decimal places.)

8. If a synchronous motor is running at a leading power factor, its excitation induced voltage (E_f) is

○ (A) equal to terminal voltage V_t ○ (B) higher than the terminal voltage V_t ○ (C) less than terminal voltage V_t
○ (D) higher than the terminal voltage V_t

9. A 3-phase, 4-pole, 400 V, 50 Hz squirrel-cage induction motor is operating at a slip of 0.02. The speed of the rotor flux in mechanical rad/sec, sensed by a stationary observer, is closest to

○ (A) 1500 ○ (B) 1470 ○ (C) 157 ○ (D) 154

10. A 220 V, 10 kW, 900 rpm separately excited DC motor has an armature resistance $R_a = 0.02\Omega$. When the motor operates at rated speed and with rated terminal voltage, the electromagnetic torque developed by the motor is 70 Nm. Neglecting the rotational losses of the machine, the current drawn by the motor from the 220 V supply is

(A) 34.2 A (B) 30 A (C) 22 A (D) 4.84 A

11. A 120 V DC shunt motor takes 2 A no load. It takes 7 A on full load while running at 1200 rpm. The armature resistance is 0.8 Ω, and shunt field resistance is 240 Ω. The no load speed, in rpm, is_____.

12. A star-connected, 12.5kW, 208 V (line), 3-phase, 60 Hz squirrel cage induction motor has following equivalent circuit parameters per phase referred to the stator: $R_1 = 0.3\ \Omega,\ R_2 = 0.3\Omega,\ X_1 = 0.41\Omega,\ X_2 = 0.41\Omega$.. Neglect shunt branch in the equivalent circuit. The starting current (in Ampere) for this motor when connected to an 80 V (line), 20 Hz, 3-phase AC source is _____.

13. A 25 kVA, 400 V, $\triangle$-connected, 3-phase, cylinder rotor synchronous generator requires a field current of 5 A to maintain the rated armature current under short-circuit condition. For the same field current, the open-circuit voltage is 360 V. Neglecting the armature resistance and magnetic saturation, its voltage regulation (in % with respect to terminal voltage), when the generator delivers the rated load at 0.8 pf leading, at rated terminal voltage is_____.

14. If the primary line voltage rating is 3.3 kV (Y side) of a 25 kVA, Y-$\triangle$ transformer (the per phase turns ratio is 5:1), then the line current rating of the secondary side (in Ampere) is_____.

2016

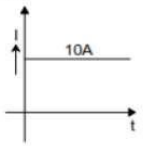
1. In a constant V/f induction motor drive, the slip at the maximum torque

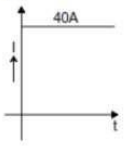
(A) is directly proportional to the synchronous speed. (B) remains constant with respect to the synchronous speed.
(C) has an inverse relation with the synchronous speed. (D) has no relation with the synchronous speed.

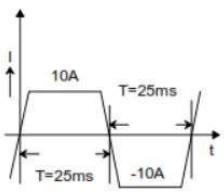
2. Consider a system consisting of a synchronous generator working at a lagging power factor, a synchronous motor working at an overexcited condition and a directly grid-connected induction generator. Consider capacitive VAr to be a source and inductive VAr to be a sink of reactive power. Which one of the following statements is TRUE?

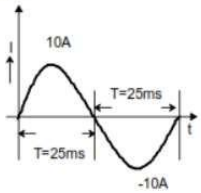
(A) Synchronous motor and synchronous generator are sources and induction generator is a sink of reactive power.
(B) Synchronous motor and induction generator are sources and synchronous generator is a sink of reactive power
(C) Synchronous motor is a source and induction generator and synchronous generator are sinks of reactive power.
(D) All are sources of reactive power.

3. A 4-pole, lap-connected, separately excited dc motor is drawing a steady current of 40 A while running at 600 rpm. A good approximation for the waveshape of the current in an armature conductor of the motor is given by

(A)


(B)


(C)


(D)


4. A single-phase 400 V, 50 Hz transformer has an iron loss of 5000 W at the rated condition. When operated at 200 V, 25 Hz, the iron loss is 2000 W. When operated at 416 V, 52 Hz, the value of the hysteresis loss divided by the eddy current loss is _____.

5. A DC shunt generator delivers 45 A at a terminal voltage of 220 V. The armature and the shunt field resistances are 0.01 Ω and 44 Ω respectively. The stray losses are 375 W. The percentage efficiency of the DC generator is _____.

6. A three-phase, 50 Hz salient-pole synchronous motor has a per-phase direct-axis reactance (X_d) of 0.8 pu and a per-phase quadrature-axis reactance (X_q) of 0.6 pu. Resistance of the machine is negligible. It is drawing full-load current at 0.8 pf (leading). When the terminal voltage is 1 pu,per-phase induced voltage, in pu, is _____.

7. A single-phase, 22 kVA, 2200 V/ 220 V, 50 Hz, distribution transformer is to be connected as an auto-transformer to get an output voltage of 2420 V. Its maximum kVA rating as an autotransformer is

(A) 22 (B) 24.2 (C) 242 (D) 2420

8. The direction of rotation of a single-phase capacitor run induction motor is reversed by

(A) interchanging the terminals of the AC supply.
(B) interchanging the terminals of the capacitor.
(C) interchanging the terminals of the auxiliary winding.
(D) interchanging the terminals of both the windings.

9. The power consumption of an industry is 500 kVA, at 0.8 p.f. lagging. A synchronous motor is added to raise the power factor of the industry to unity. If the power intake of the motor is 100 kW, the p.f. of the motor is _____

10. The flux linkage (λ) and current (i) relation for an electromagnetic system is $\lambda = \left(\sqrt{i}\right)/\mathrm{g}$. When $i = 2A$ and g (air-gap length) $= 10\ cm$, the magnitude of mechanical force on the moving part, in N, is _____.

11. The starting line current of a 415 V, 3-phase, delta connected induction motor is 120 A, when the rated voltage is applied to its stator winding. The starting line current at a reduced voltage of 110 V, in ampere, is _____.

12. A single-phase, 2 kVA, 100/200 V transformer is reconnected as an auto-transformer such that its kVA rating is maximum. The new rating, in kVA, is _____.

13. Three single-phase transformers are connected to form a delta-star three-phase transformer of 110 kV/ 11 kV. The transformer supplies at 11 kV a load of 8 MW at 0.8 p.f. lagging to a nearby plant. Neglect the transformer losses. The ratio of phase currents in delta side to star side is

(A) $1 : 10\sqrt{3}$ (B) $10\sqrt{3} : 1$ (C) $1 : 10$ (D) $\sqrt{3} : 10$

2015

1. A separately excited DC generator has an armature resistance of 0.1Ω and negligible armature inductance. At rated field current and rated rotor speed, its open-circuit voltage is 200 V. When this generator is operated at half the rated speed, with half the rated field current, an un-charged 1000 μF capacitor is suddenly connected across the armature terminals. Assume that the speed remains unchanged during the transient. At what time (in microsecond) after the capacitor is connected will the voltage across it reach 25 V?

(A) 62.25 (B) 69.3 (C) 73.25 (D) 77.3

2. The self inductance of the primary winding of a single phase, 50 Hz, transformer is 800 mH, and that of the secondary winding is 600 mH. The mutual inductance between these two windings is 480 mH. The secondary winding of this transformer is short circuited and the primary winding is connected to a 50 Hz, single phase, sinusoidal voltage source. The current flowing in both the winding is less than their respective rated currents. The resistance of both windings can be neglected. In this connection, what is the effective inductance (in mH) seen by the source?

(A) 416 (B) 440 (C) 200 (D) 920

3. The primary mmf is least affected by the secondary terminal conditions in a

(A) power transformer (B) potential transformer (C) current transformer (D) distribution transformer

4. A 3-phase 50 Hz square wave (6-step) VSI feeds a 3-phase, 4 pole induction motor. The VSI line voltage has a dominant 5^{th} harmonic component. If the operating slip of the motor with respect to fundamental component voltage is 0.04, the slip of the motor with respect to 5^{th} harmonic component of voltage is _____.

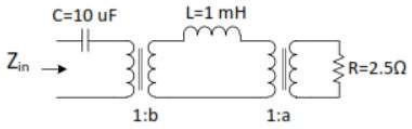
5. A separately excited DC motor runs at 1000 rpm on no load when its armature terminals are connected to a 200V DC source and the rated voltage is applied to the field winding. The armature resistance of this motor is 1Ω. The no-load armature current is negligible. With the motor developing its full load torque, the armature voltage is set so that the rotor speed is 500 rpm. When the load torque is reduced to 50% of the full load value under the same armature voltage conditions, the speed rises to 520 rpm. Neglecting the rotational losses, the full load armature current (in Ampere) is _____.

6. A DC motor has the following specifications: 10 hp, 37.5 A, 230V; flux/pole = 0.01 Wb,number of poles = 4, number of conductors = 666, number of parallel paths = 2. Armature resistance = 0.267Ω. The armature reaction is negligible and rotational losses are 600W. The motor operates from a 230V DC supply. If the motor runs at 1000 rpm, the output torque produced in (in Nm) is _____.

7. A 200/400 V, 50 Hz, two-winding transformer is rated at 20 kVA. Its windings are connected as an auto-transformer of rating 200/600 V. A resistive load of 12Ω is connected to the high voltage (600 V) side of the auto-transformer. The value of equivalent load resistance (in Ohm) as seen from low voltage side is _____.

8. Two single-phase transformers T_1 and T_2 each rated at 500 kVA are operated in parallel. Percentage impedances of T_1 and T_2 are (1+j6) and (0.8+j4.8), respectively. To share a load of 1000 kVA at 0.8 lagging power factor, the contribution of T_2 (in kVA) is _____.

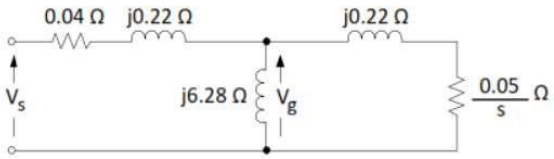
9. Find the transformer ratios a and b that the impedance (Z_{in}) is resistive and equal 2.5Ω when the network is excited with a sine wave voltage of angular frequency of 5000 rad/s.



○ (A) a=0.5, b=2.0 ○ (B) a=2.0, b=0.5 ○ (C) a= 1.0, b=1.0 ○ (D) a=4.0, b=0.5

10. A shunt-connected DC motor operates at its rated terminal voltage. Its no-load speed is 200 radians/second. At its rated torque of 500 Nm, its speed is 180 radian/second. The motor is used to directly drive a load whose load torque T_L depends on its rotational speed ω_r(in radians/second), such that T_L=2.78×ω_r. Neglecting rotational losses, the steady-state speed (in radian/second) of the motor, when it drives this load is _____.

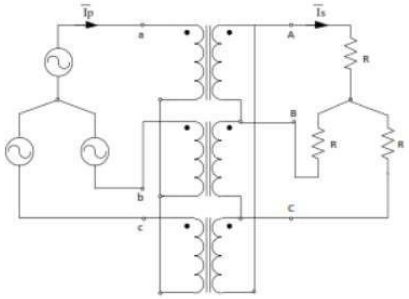
11. The figure shows the per-phase equivalent circuit of a two-pole three-phase induction motor operating at 50 Hz. The "air-gap" voltage, V_g across the magnetizing inductance, is 210 V rms, and the slip, s, is 0.005. The torque (in Nm) produced by the motor is _____.



12. A 4-pole, separately excited, wave wound DC machine with negligible armature resistance is rated for 230 V and 5 kW at a speed of 1200 rpm. If the same armature coils are reconnected to forms a lap winding, what is the rated voltage (in volts) and power (in kW) respectively at 1200 rpm of the reconnected machine if the field circuit is left unchanged?

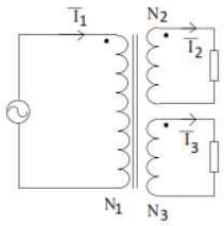
○ (A) 230 and 5 ○ (B) 115 and 5 ○ (C) 115 and 2.5 ○ (D) 230 and 2.5

13. A balanced (positive sequence) three-phase AC voltage source is connected to a balanced, start connected through a star-delta transformer as shown in the figure. The line-to-line voltage rating is 230 V on the star side, and 115 V on the delta side. If the magnetizing current is neglected and $\overline{I_s} = 100\angle 0^\circ$ A, then what is the value of $\overline{I_p}$ in Ampere?



○ (A) $50\angle 30^\circ$ ○ (B) $50\angle -30^\circ$ ○ (C) $50\sqrt{3}\angle 30^\circ$ ○ (D) $200\angle 30^\circ$

14. A three-winding transformer is connected to an AC voltage source as shown in the figure.The number of turns are as follows: N_1 = 100, N_2 = 50, N_3 = 50. If the magnetizing current is neglected, and the currents in two windings are $\overline{I_2} = 2\angle 30^\circ$ A and $\overline{I_3} = 2\angle 150^\circ$A, then what is the value of the current $\overline{I_1}$ in Ampere?



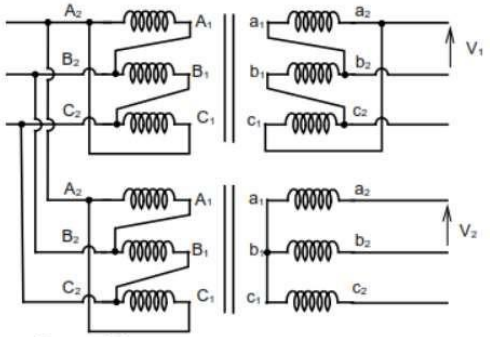
○ (A) $1\angle 90^\circ$ ○ (B) $1\angle 270^\circ$ ○ (C) $4\angle 90^\circ$ ○ (D) $4\angle 270^\circ$

15. With an armature voltage of 100 V and rated field winding voltage, the speed of a separately excited DC motor driving a fan is 1000 rpm, and its armature current is 10 A. The armature resistance is 1Ω. The load torque of the fan load is proportional to the square of the rotor speed. Neglecting rotational losses, the value of the armature voltage (in Volt) which will reduce the rotor speed to 500 rpm is _____.

16. A three-phase, 11 kV, 50 Hz, 2 pole, star connected, cylindrical rotor synchronous motor is connected to an 11 kV, 50 Hz source, Its synchronous reactance is 50Ω per phase, and its stator resistance is negligible. The motor has a constant field excitation. At a particular load torque, its stator current is 100 A at unity power factor. If the load torque is increased so that the stator current is 120 A, then the load angle (in degrees) at this load is ___.

17. A 220 V, 3-phase, 4-pole, 50 Hz inductor motor of wound rotor type is supplied at rated voltage and frequency. The stator resistance, magnetizing reactance, and core loss are negligible. The maximum torque produced by the rotor is 225% of full load torque and it occurs at 15% slip. The actual rotor resistance is 0.03Ω/ phase. The value of external resistance (in Ohm) which must be inserted in a rotor phase if the maximum torque is to occur at start is _____.

18. Two three-phase transformers are realized using single-phase transformers as shown in the figure.



The phase different (in degree) between voltage V_1 and V_2 is _____.

2014

1. An 8-pole, 3-phase, 50 Hz induction motor is operating at a speed of 700 rpm. The frequency of the rotor current of the motor in Hz is _____.

2. For a specified input voltage and frequency, if the equivalent radius of the core of a transformer is reduced by half, the factor by which the number of turns in the primary should change to maintain the same no load current is

(A) 1/4 (B) 1/2 (C) 2 (D) 4

3. A star connected 400 V, 50 Hz, 4 pole synchronous machine gave the following open circuit and short circuit test results:
Open circuit test: V_{oc} = 400 V (rms, line-to-line) at field current, I_f = 2.3 A
Short circuit test: I_{sc} = 10 A (rms, phase) at field current, I_f = 1.5 A

The value of per phase synchronous impedance in Ω at rated voltage is _____.

4. The core loss of a single phase, 230/115 V, 50 Hz power transformer is measured from 230 V side by feeding the primary (230 V side) from a variable voltage variable frequency source while keeping the secondary open circuited. The core loss is measured to be 1050 W for 230 V, 50 Hz input. The core loss is again measured to be 500 W for 138 V, 30 Hz input. The hysteresis and eddy current losses of the transformer for 230 V, 50 Hz input are respectively,

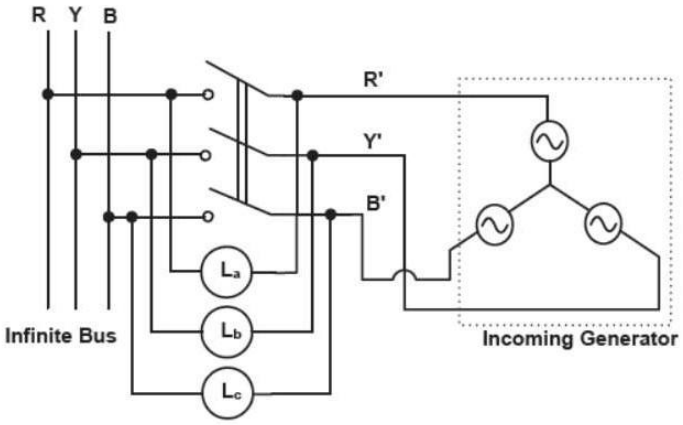
(A) 508 W and 542 W. (B) 468 W and 582 W. (C) 498 W and 552 W. (D) 488 W and 562 W.

5. A 15 kW, 230 V dc shunt motor has armature circuit resistance of 0.4 Ω and field circuit resistance of 230 Ω. At no load and rated voltage, the motor runs at 1400 rpm and the line current drawn by the motor is 5 A. At full load, the motor draws a line current of 70 A. Neglect armature reaction. The full load speed of the motor in rpm is _____.

6. A 3 phase, 50 Hz, six pole induction motor has a rotor resistance of 0.1 Ω and reactance of 0.92 Ω. Neglect the voltage drop in stator and assume that the rotor resistance is constant. Given that the full load slip is 3%, the ratio of maximum torque to full load torque is

(A) 1.567 (B) 1.712 (C) 1.948 (D) 2.134

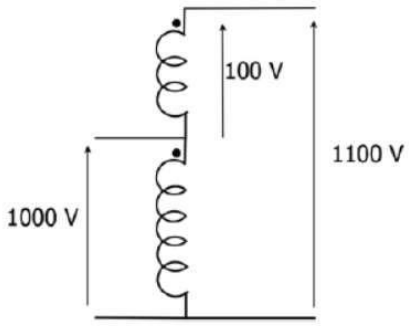
7. A three phase synchronous generator is to be connected to the infinite bus. The lamps are connected as shown in the figure for the synchronization. The phase sequence of bus voltage is R-Y-B and that of incoming generator voltage is R'-Y'-B'.



It was found that the lamps are becoming dark in the sequence L_a-L_b-L_c. It means that the phase sequence of incoming generator is

- (A) opposite to infinite bus and its frequency is more than infinite bus
- (B) opposite to infinite bus but its frequency is less than infinite bus
- (C) same as infinite bus and its frequency is more than infinite bus
- (D) same as infinite bus and its frequency is less than infinite bus

8. A single phase, 50 kVA, 1000V/100 V two winding transformer is connected as an autotransformer as shown in the figure.



The kVA rating of the autotransformer is _____.

9. A three-phase, 4-pole, self excited induction generator is feeding power to a load at a frequency f_1. If the load is partially removed, the frequency becomes f_2. If the speed of the generator is maintained at 1500 rpm in both the cases, then

- (A) $f_1, f_2 > 50$ Hz and $f_1 > f_2$
- (B) $f_1 < 50$ Hz and $f_2 > 50$ Hz
- (C) $f_1, f_2 < 50$ Hz and $f_2 > f_1$
- (D) $f_1 > 50$ Hz and $f_2 < 50$ Hz

10. In a constant V/f control of induction motor, the ratio V/f is maintained constant from 0 to base frequency, where V is the voltage applied to the motor at fundamental frequency f. Which of the following statements relating to low frequency operation of the motor is TRUE?

- (A) At low frequency, the stator flux increases from its rated value.
- (B) At low frequency, the stator flux decreases from its rated value.
- (C) At low frequency, the motor saturates.
- (D) At low frequency, the stator flux remains unchanged at its rated value.

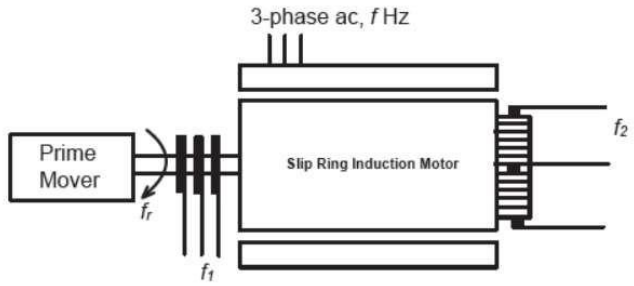
11. A 250 V dc shunt machine has armature circuit resistance of 0.6 Ω and field circuit resistance of 125 Ω. The machine is connected to 250 V supply mains. The motor is operated as a generator and then as a motor separately. The line current of the machine in both the cases is 50 A. The ratio of the speed as a generator to the speed as a motor is _____.

12. In a constant V/f control of induction motor, the ratio V/f is maintained constant from 0 to base frequency, where V is the voltage applied to the motor at fundamental frequency f. Which of the following statements relating to low frequency operation of the motor is TRUE?

- (A) At low frequency, the stator flux increases from its rated value.
- (B) At low frequency, the stator flux decreases from its rated value.
- (C) At low frequency, the motor saturates.
- (D) At low frequency, the stator flux remains unchanged at its rated value.

13. A 250 V dc shunt machine has armature circuit resistance of 0.6 Ω and field circuit resistance of 125 Ω. The machine is connected to 250 V supply mains. The motor is operated as a generator and then as a motor separately. The line current of the machine in both the cases is 50 A. The ratio of the speed as a generator to the speed as a motor is _____.

14. A three-phase slip-ring induction motor, provided with a commutator winding, is shown in the figure. The motor rotates in clockwise direction when the rotor windings are closed.



If the rotor winding is open circuited and the system is made to run at rotational speed f_r with the help of prime-mover in anti-clockwise direction, then the frequency of voltage across slip rings is f_1 and frequency of voltage across commutator brushes is f_2. The values of f_1 and f_2 respectively are

○ (A) $f+f_r$ and f ○ (B) $f-f_r$ and f ○ (C) $f-f_r$ and $f+f_r$ ○ (D) $f+f_r$ and $f-f_r$

15. A 20-pole alternator is having 180 identical stator slots with 6 conductors in each slot. All the coils of a phase are in series. If the coils are connected to realize single-phase winding, the generated voltage is V_1. If the coils are reconnected to realize three-phase star-connected winding, the generated phase voltage is V_2. Assuming full pitch, single-layer winding, the ratio V_1/V_2 is

○ (A) $\frac{1}{\sqrt{3}}$ ○ (B) $\frac{1}{2}$ ○ (C) $\sqrt{3}$ ○ (D) 2

16. For a single phase, two winding transformer, the supply frequency and voltage are both increased by 10%. The percentage changes in the hysteresis loss and eddy current loss, respectively, are

○ (A) 10 and 21 ○ (B) -10 and 21 ○ (C) 21 and 10 ○ (D) -21 and 10

17. A synchronous generator is connected to an infinite bus with excitation voltage E_f = 1.3 pu. The generator has a synchronous reactance of 1.1 pu and is delivering real power (P) of 0.6 pu to the bus. Assume the infinite bus voltage to be 1.0 pu. Neglect stator resistance. The reactive power (Q) in pu supplied by the generator to the bus under this condition is _____.

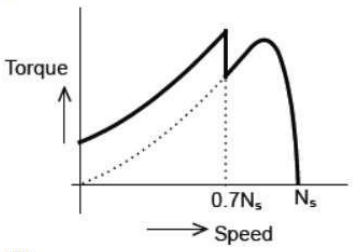
18. There are two generators in a power system. No-load frequencies of the generators are 51.5 Hz and 51 Hz, respectively, and both are having droop constant of 1 Hz/MW. Total load in the system is 2.5 MW. Assuming that the generators are operating under their respective droop characteristics, the frequency of the power system in Hz in the steady state is _____.

19. In a synchronous machine, hunting is predominantly damped by

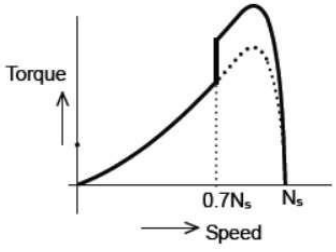
○ (A) mechanical losses in the rotor ○ (B) iron losses in the rotor ○ (C) copper losses in the stator ○ (D) copper losses in the rotor

20. A single phase induction motor is provided with capacitor and centrifugal switch in series with auxiliary winding. The switch is expected to operate at a speed of 0.7 Ns, but due to malfunctioning the switch fails to operate. The torque-speed characteristic of the motor is represented by

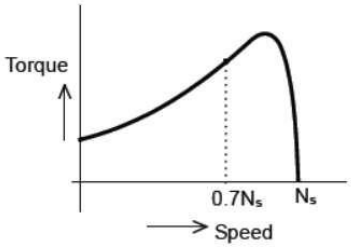
○ (A)



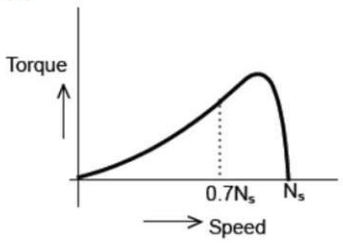
○ (B)



○ (C)

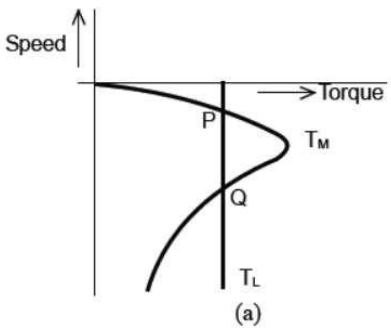


○ (D)

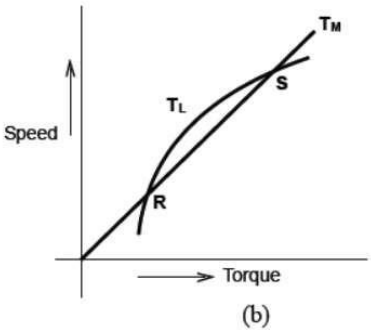


21. The no-load speed of a 230 V separately excited dc motor is 1400 rpm. The armature resistance drop and the brush drop are neglected. The field current is kept constant at rated value. The torque of the motor in Nm for an armature current of 8 A is _____.

22. The torque-speed characteristics of motor (T_M) and load (T_L) for two cases are shown in the figures (a) and (b). The load torque is equal to motor torque at points P, Q, R and S



(a)

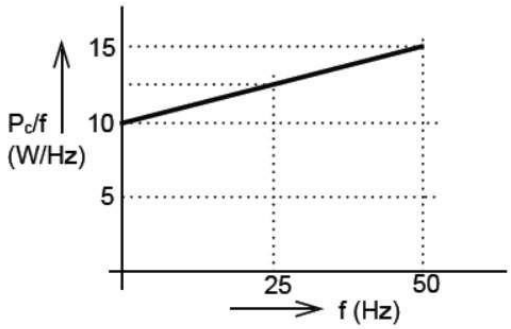


(b)

The stable operating points are

(A) P and R (B) P and S (C) Q and R (D) Q and S

23. An open circuit test is performed on 50 Hz transformer, using variable frequency source and keeping V/f ratio constant, to separate its eddy current and hysteresis losses. The variation of core loss/frequency as function of frequency is shown in the figure



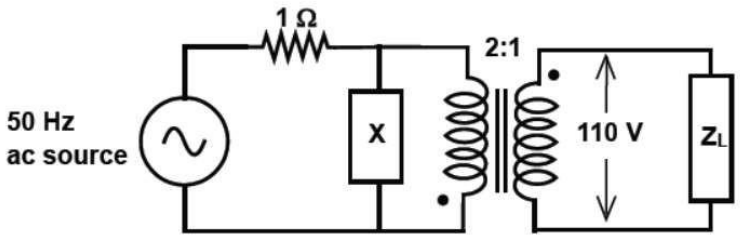
The hysteresis and eddy current losses of the transformer at 25 Hz respectively are

(A) 250 W and 2.5 W (B) 250 W and 62.5W (C) 312.5 W and 62.5 W (D) 312.5 W and 250 W

24. A non-salient pole synchronous generator having synchronous reactance of 0.8 pu is supplying 1 pu power to a unity power factor load at a terminal voltage of 1.1 pu. Neglecting the armature resistance, the angle of the voltage behind the synchronous reactance with respect to the angle of the terminal voltage in degrees is _____.

25. A separately excited 300 V DC shunt motor under no load runs at 900 rpm drawing an armature current of 2 A. The armature resistance is 0.5 Ω and leakage inductance is 0.01 H. When loaded, the armature current is 15 A. Then the speed in rpm is ____

26. The load shown in the figure absorbs 4 kW at a power factor of 0.89 lagging.



Assuming the transformer to be ideal, the value of the reactance X to improve the input power factor to unity is _____.

27. The parameters measured for a 220V/110V, 50 Hz, single-phase transformer are:
Self inductance of primary winding = 45 mH
Self inductance of secondary winding = 30 mH
Mutual inductance between primary and secondary windings = 20 mH
Using the above parameters, the leakage (L_{l1} , L_{l2}) and magnetizing (L_m) inductances as referred to primary side in the equivalent circuit respectively, are

(A) 5mH, 20mH and 40mH (B) 5mH, 80mH and 40mH (C) 25mH, 10mH and 20mH (D) 45mH, 30mH and 20mH

2013

1. A single-phase transformer has no-load loss of 64 W, as obtained from an open-circuit test. When a short-circuit test is performed on it with 90% of the rated currents flowing in its both LV and HV windings, the measured loss is 81 W. The transformer has maximum efficiency when operated at

(A) 50.0% of the rated current. (B) 64.0% of the rated current. (C) 80.0% of the rated current. (D) 88.8% of the rated current.

2. The angle δ in the swing equation of a synchronous generator is the

(A) angle between stator voltage and current. (B) angular displacement of the rotor with respect to the stator.
(C) angular displacement of the stator mmf with respect to a synchronously rotating axis.
(D) angular displacement of an axis fixed to the rotor with respect to a synchronously rotating axis.

3. Leakage flux in an induction motor is

(A) flux that leaks through the machine (B) flux that links both stator and rotor windings (C) flux that links none of the windings
(D) flux that links the stator winding or the rotor winding but not both

4. A 4-pole induction motor, supplied by a slightly unbalanced three-phase 50 Hz source, is rotating at 1440 rpm. The electrical frequency in Hz of the induced negative sequence current in the rotor is

(A) 100 (B) 98 (C) 52 (D) 48

2012

1. The slip of an induction motor normally does not depend on

(A) rotor speed (B) synchronous speed (C) shaft torque (D) core-loss component

2. A 220 V, 15 kW, 1000 rpm shunt motor with armature resistance of 0.25Ω; has a rated line current of 68 A and a rated field current of 2.2 A. The change in field flux required to obtain a speed of 1600 rpm while drawing a line current of 52.8 A and a field current of 1.8 A is

(A) 18.18 % increase (B) 18.18 % decrease (C) 36.36 % increase (D) 36.36 % decrease

3. The locked rotor current in a 3-phase, star connected 15 kW, 4-pole, 230 V, 50 Hz induction motor at rated conditions is 50 A. Neglecting losses and magnetizing current, the approximate locked rotor line current drawn when the motor is connected to a 236 V, 57 Hz supply is

(A) 58.5 A (B) 45.0 A (C) 42.7 A (D) 55.6 A

4. A single phase 10 kVA, 50 Hz transformer with 1 kV primary winding draws 0.5 A and 55 W, at rated voltage and frequency, on no load. A second transformer has a core with all its linear dimensions $\sqrt{2}$ times the corresponding dimensions of the first transformer. The core material and lamination thickness are the same in both transformers. The primary windings of both the transformers have the same number of turns. If a rated voltage of 2 kV at 50 Hz is applied to the primary of the second transformer, then the no load current and power, respectively, are

(A) 0.7 A, 77.8 W (B) 0.7 A, 155.6 W (C) 1 A, 110 W (D) 1 A, 220 W

2011

1. A 4 point starter is used to start and control the speed of a

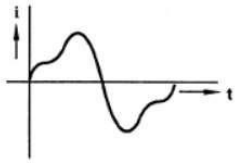
(A) dc shunt motor with armature resistance control (B) dc shunt motor with field weakening control (C) dc series motor
(D) dc compound motor

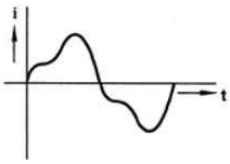
2. A three phase, salient pole synchronous motor is connected to an infinite bus. It is operated at no load a normal excitation. The field excitation of the motor is first reduced to zero and then increased in reverse direction gradually. Then the armature current

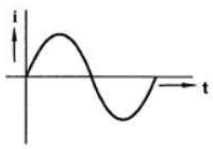
(A) increases continuously (B) first increases and then decreases steeply (C) first decreases and then increases steeply

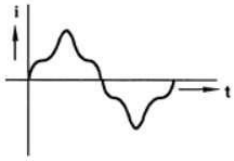
(D) remains constant

3. A single phase air core transformer, fed from a rated sinusoidal supply, is operating at no load. The steady state magnetizing current drawn by the transformer from the supply will have the waveform

(A) 

(B) 

(C) 

(D) 

4. A 220 V, DC shunt motor is operating at a speed of 1440 rpm. The armature resistance is 1.0 Ω and armature current is 10 A. If the excitation of the machine is reduced by 10%, the extra resistance to be put in the armature circuit to maintain the same speed and torque will be

(A) 1.79 Ω (B) 2.1Ω (C) 3.1Ω (D) 18.9Ω

5. A three-phase 440 V, 6 pole, 50 Hz, squirrel cage induction motor is running at a slip of 5%. The speed of stator magnetic field to rotor magnetic field and speed of rotor with respect of stator magnetic field are

(A) zero, −5 rpm (B) zero, 955 rpm (C) 1000 rpm, −5 rpm (D) 1000 rpm, 955 rpm

6. The direct axis and quadrature axis reactances of a salient pole alternator are 1.2 p.u and 1.0 p.u respectively. The armature resistance is negligible. If this alternator is delivering rated kVA at upf and at rated voltage then its power angle is

(A) 30° (B) 45° (C) 60° (D) 90°