MADE EASY PUBLICATIONS

POSTAL BOOK PACKAGE 2027

ELECTRICAL ENGINEERING

OBJECTIVE PRACTICE SETS VOLUME - III

CONTENTS

■■■■

ELECTRIC MACHINES

OBJECTIVE PRACTICE SETS

Page No. 2 - 131

1 CHAPTER
Magnetic Circuit

Q.1 The laws of electromagnetic induction are summarized in the following equation:

(a) $e = L\frac{di}{dt}$ (b) $e = iR$

(c) $e = -\frac{d\psi}{dt}$ (d) None of these

Q.2 A coil of 1000 turns is wound on a core. A current of 1 A flowing through the coil creates a core flux of 1 mWb. What is the energy stored in the magnetic field?

(a) 1 J (b) $\frac{1}{4}$ J

(c) 2 J (d) $\frac{1}{2}$ J

Q.3 **Assertion (A) :** In an electric circuit, the current is due to the presence of electromotive force.
Reason (R) : In a magnetic circuit, the magnetic flux is due to the presence of a magnetomotive force.

(a) Both A and R are true and R is a correct explanation of A.
(b) Both A and R are true but R is not a correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.4 Consider the following statements regarding methods to increase the mutual inductance between two mutually coupled circuits.

1. Increase in the number of primary turns.
2. Increase in the number of secondary turns.
3. Decrease in the permeance offered to the mutual flux.
4. Decrease in the leakage flux.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 1, 2 and 4
(c) 2, 3 and 4 (d) 1, 2, 3 and 4

Q.5 For a linear electromagnetic circuit, the following statement is true.

(a) Field energy is equal to the co-energy.
(b) Field energy is greater than the co-energy.
(c) Field energy is lesser than the co-energy.
(d) Co-energy is zero.

Q.6 In which region of B-H curve a permanent magnet operating point lie:

(a) Second quadrant of B-H curve
(b) Second and third quadrant of B-H curve
(c) Fourth quadrant of B-H curve
(d) First quadrant of B-H curve

Q.7 A magnetic circuit with relative permeability of 50 having mean core length of 30 cm and cross sectional area of 10 cm^2, the value of permeance is _____ $\times 10^{-7}$ Wb/AT.

Q.8 The emf induced in a conductor of machine driven at 600 rpm, the peak value of flux density is 1.0 Wb/m^2, diameter of machine 2.0 meter and length of machine 0.30 m is

(a) 41.83 V (b) 29.58 V
(c) 9.42 V (d) 18.84 V

Q.9 An iron-cored choke, with 2 mm air-gap length, takes 2 A when fed from a constant-voltage source of 230 V. If its air-gap length is increased to 10 mm, then the magnetic flux produced by the choke would

(a) remains constant and the current would increase.
(b) decrease and the current would increase.
(c) decrease and the current would also decrease.
(d) remain constant and the current would decrease.

Q.10 **Assertion (A) :** Leakage flux does not follow the intended path in a magnetic circuit.
Reason (R) : In a magnetic circuit, all the flux produced by a coil is confined to desired magnetic path.

(a) Both A and R are true and R is a correct explanation of A.

(b) Both A and R are true but R is not a correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Q.11 The field winding of a dc electro-magnet is wound with 960 turns and has a resistance of 50 Ω. The excitation voltage is 230 V and the magnetic flux linking the coil is 5 mWb. The energy stored in the magnetic field is
(a) 22 Joules (b) 11 Joules
(c) 19 Joules (d) 29 Joules

Q.12 A coil with 60 turns wound over a ferromagnetic core having relative permeability of 400 has an inductance of 50 mH. If coil turns are doubled and the core is replaced by a new ferromagnetic core having relative permeability 600, the new inductance would be
(a) 0.15 H (b) 0.3 H
(c) 1.5 H (d) 3 H

Q.13 A magnetic circuit has 150 turns-coil, the cross-sectional area 5×10^{-4} m^2 and the length of the magnetic circuit 25×10^{-2} m. What are the values of magnetic field intensity and relative permeability when the current is 2 A and total flux is 0.3×10^{-3} Wb?
(a) 1200 AT/m and 397.9
(b) 300 AT/m and 500×10^{-6}
(c) 300 AT/m and 397.9
(d) 1200 AT/m and 500×10^{-6}

Q.14 The flux in a magnetic core is alternating sinusoidally at a frequency of 600 Hz. The maximum flux density is 2 Tesla and the eddy current loss is 15 Watts. What would be the eddy current loss in the core if the frequency is raised to 800 Hz and the maximum flux density is reduced to 1.5 Tesla?
(a) 12 Watts (b) 25.25 Watts
(c) 15 Watts (d) 18 Watts

Q.15 In contrast to an electric circuit magnetic circuit is
(a) non-dissipative in dc excitation but dissipative and non-inductive in ac excitation.
(b) non-dissipative in both ac and dc excitation but non-inductive in ac excitation.
(c) dissipative in both ac and dc excitation and inductive in ac excitation.
(d) dissipative in both ac and dc excitation and non-inductive in ac excitation.

Q.16 Iron is removed from the iron cored coil so that the coil becomes air-cored coil. Inductance of this air-cored coil will
(a) increase
(b) decrease
(c) remain the same
(d) increase or decrease depending upon the coil configuration

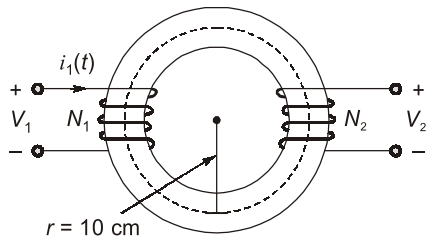
Q.17 In a magnetic circuit, following values of fluxes are given:
Flux through magnetic core = 0.5 mWb
Leakage flux = 0.1 mWb
The value of leakage factor will be _____ .

Q.18 A magnetic circuit with a relative permeability of 50 has a core cross section of 5 cm^2 and mean core length of 25 cm. The coil on the core has 120 turns with an mmf of 500 AT. The magnetic core flux is
(a) 0.06 mWb (b) 0.25 mWb
(c) 0.75 mWb (d) 1 mWb

Q.19 A steel core having cross sectional area of 25 cm^2 and mean radius of 10 cm. For a relative permeability of 500 and a 400 turns coil producing a flux of 0.8 mWb in the ring, the value of current in exciting coil is _____ A.

Q.20 The flux linkage (λ) and current (i) relation for an electromagnetic system is $\lambda = (\sqrt{i})/g$. When i = 2 A and g(air-gap length) = 10 cm, the magnitude of mechanical force on the moving part, in N, is _____.

Q.21 The magnetic circuit shown below has a uniform cross section of 10^{-3} m^2. If the circuit is energized by a current $i_1(t) = 3 \sin 100\pi t$ ampere in the coil of N_1 = 200 turns, the emf induced in the coil (in V) of N_2 = 100 turns is
(Assume $\mu = 500\ \mu_0$)



(a) $\frac{8\pi}{\sqrt{2}}$(rms) and leading the current by 90°.

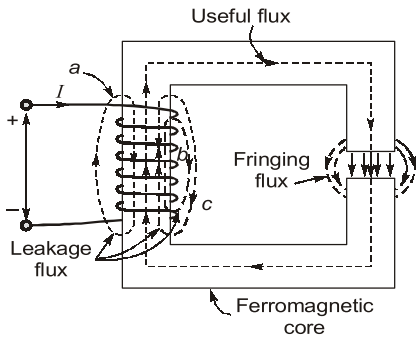
(b) $\frac{6\pi}{\sqrt{2}}$(rms) and lagging the current by 90°.

(c) $\frac{4\pi}{\sqrt{2}}$(rms) and leading the current by 90°.

(d) $\frac{5\pi}{\sqrt{2}}$(rms) and lagging the current by 90°.

Q.22 A coil of 100 turns is wound on a toroidal magnetic core having a reluctance of 10^4 AT/Wb. When the coil current is 5 A and is increasing at the rate of 200 A/s, the voltage across the coil would be (Assume coil resistance to be 2 Ω)

Q.23 The magnetic circuit shown below have following data:



Area of cross section = 5×5 cm^2

Core length = 40 cm

Gap length = 4 mm

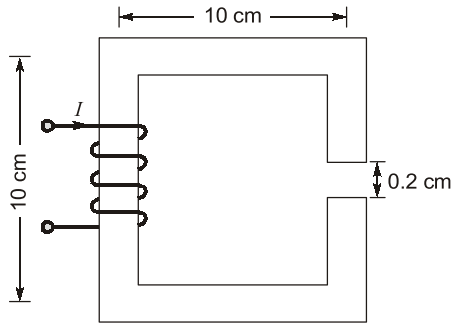
N = 560 turns

For a flux density of 1.5 T, the exciting current is (Take μ_r = 10000 for iron and neglect fringing effects)

(a) 7.26 A (b) 8.61 A

(c) 6.52 A (d) None

Q.24 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 _____.



■■■■

Answers Magnetic Circuit

1. (c)	2. (d)	3. (b)	4. (b)	5. (a)	6. (a)	7. (2.09)	8. (d)	9. (a)
10. (d)	11. (b)	12. (b)	13. (a)	14. (c)	15. (d)	16. (b)	17. (1.2)	18. (a)
19. (0.8)	20. (188.56)		21. (b)	22. (210)	23. (b)	24. (0.833)		

Explanations Magnetic Circuit

1. (c)

From Faraday's law of electromagnetic induction,

$$e = -\frac{d\psi}{dt}$$

(minus sign is due to Lenz's law).

2. (d)

$$L = \frac{N\phi}{I} = \frac{1000 \times 10^{-3}}{1} = 1\ \text{H}$$

$$\therefore \text{ Energy stored} = \frac{1}{2}LI^2 = \frac{1}{2} \times 1 \times 1^2$$

$$= \frac{1}{2}\ \text{Joule}$$

3. (b)

- For an electrical circuit,

$$I = \frac{\text{Emf}}{R}$$

- For a magnetic circuit

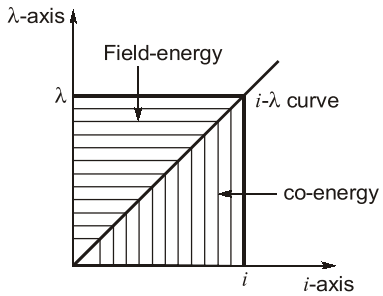
$$\phi = \frac{\text{Mmf}}{\text{Reluctance}}$$

- Current in electric circuit is analogous to flux in magnetic circuit.

4. (b)

Mutual inductance between two circuits can be increased by increasing the permeance or decreasing the reluctance offered to the mutual flux.

5. (a)



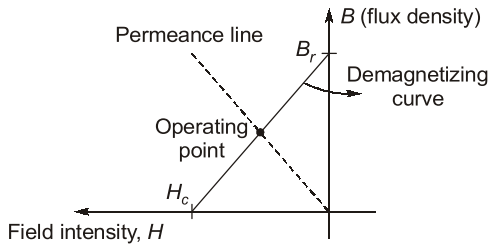
Where, $\lambda = N\phi$ = Flux linkage

Field energy is the energy absorbed by the magnetic system to establish flux ϕ.

For a linear electromagnetic circuit

$$\text{Field energy} = \text{Co-energy} = \frac{1}{2}\lambda i$$

6. (a)



7. Sol.

Given, $l = 30\ \text{cm} = 0.3\ \text{m}$

$\mu_r = 50$

$\mu_0 = 4\pi \times 10^{-7}\ \text{H/m}$

$A = 10\ \text{cm}^2 = 10 \times 10^{-4}\ \text{m}^2$

$$\because \quad \text{Reluctance} = \frac{l}{\mu_0\mu_r \cdot A}$$

$$\therefore \text{ Permeance } (P) = \frac{1}{\text{Reluctance}} = \frac{\mu_0\mu_r \cdot A}{l}$$

$$= \frac{4\pi \times 10^{-7} \times 50 \times 10 \times 10^{-4}}{0.3}$$

$$= 2.09 \times 10^{-7}\ \text{Wb/AT}$$

8. (d)

$$\text{Area} = A = 2\pi rl = 2\pi \times 1 \times 0.3 = 0.6\pi$$

$$\phi = BA = 1 \times 0.6\pi = 0.6\pi$$

$$\text{Induced emf} = \frac{\phi}{T} = \frac{\phi N}{60} = 0.6\pi \times \frac{600}{60}$$

$$= 18.84\ \text{V}$$

Hence, option (d) is correct.

9. (a)

Since length of air-gap is increased, therefore, reluctance offered to the magnetic circuit will increase.

Also, $\text{Flux} = \dfrac{MMF}{\text{Reluctance}} = \dfrac{NI}{\text{Reluctance}}$

Hence, to maintain the constant flux, the choke will draw more current so that the net mmf is increased.

10. (d)

- Reason (R) is not a correct statement as, this is only true for an ideal magnetic circuit, but not for all magnetic circuits in general.
- In practical magnetic circuits, a small amount of flux does follow a path through the surrounding air and is called leakage flux.

11. (b)

Current through the field winding,

$$I = \frac{\text{Excitation voltage}}{\text{Field winding resistance}}$$

$$= \frac{230}{50} = 4.6 \text{ A}$$

Given, $\phi = 5$ mWb

$\therefore$ Inductance of coil,

$$L = \frac{N\phi}{I} = \frac{960 \times 0.005}{4.6}$$

$$= 1.043 \text{ H}$$

So, energy stored in magnetic field

$$= \frac{1}{2}LI^2 = \frac{1}{2} \times 1.043 \times (4.6)^2$$

$$= 11.04 \text{ J} \approx 11 \text{ Joules}$$

12. (b)

$$L = \frac{N^2 \mu_0 \mu_r A}{l} \quad \text{or} \quad L \propto N^2 \mu_r$$

$$\therefore \quad \frac{L_2}{L_1} = \left(\frac{N_2}{N_1}\right)^2 \times \left(\frac{\mu_{r_2}}{\mu_{r_1}}\right)$$

or, $\dfrac{L_2}{L_1} = (2)^2 \times \dfrac{600}{400} = 6$

or, $L_2 = 6L_1$

or, $L_2 = 6 \times 50 \times 10^{-3} = 0.3$ H

13. (a)

$$H = \frac{NI}{l} = \frac{150 \times 2}{25 \times 10^{-2}} = 1200 \text{ AT/m}$$

and $B = \mu_0 \mu_r H = \dfrac{\phi}{A}$

$$\Rightarrow \quad \mu_r = \frac{0.3 \times 10^{-3}}{5 \times 10^{-4} \times 4\pi \times 10^{-7} \times 1200} = 397.9$$

14. (c)

We know that eddy current loss,

$$P_e \propto f^2 B_m^2$$

$$\therefore \quad \frac{P_{e2}}{P_{e1}} = \left(\frac{f_2}{f_1}\right)^2 \times \left(\frac{B_{m2}}{B_1}\right)^2$$

or, $P_{e2} = P_{e1} \times \left(\dfrac{f_2}{f_1}\right)^2 \times \left(\dfrac{B_{m2}}{B_{m1}}\right)^2$

$$= 15 \times \left(\frac{1.5}{2}\right)^2 \times \left(\frac{800}{600}\right)^2 = 15 \text{ W}$$

15. (d)

Magnetic circuit is dissipation in both ac and dc excitation and non-inductive in ac excitation unlike an, electric circuit.

16. (b)

We know that inductance,

$$L \propto \mu \text{ (Permeability)} \propto \mu_0 \mu_r \propto \mu_r$$

Since relative permeability of iron is more than that of air ($\mu_r = 1$) therefore, with iron-cored coil L will be more while with air-cored coil L will be less.

17. Sol.

$\because$ Useful flux = Flux through magnetic core

$\therefore$ Total flux through exciting winding

= useful flux + leakage flux

λ = Leakage factor

i.e. $\lambda = \dfrac{\text{Total flux through exciting winding}}{\text{Useful flux}}$

Hence,

$$\lambda = \frac{0.5 + 0.1}{0.5} = 1.2$$

18. (a)

Given, $\mu_r = 50$, $\mu_0 = 4\pi \times 10^{-7}$ H/m

We know that, $\mu = \mu_0 \mu_r$

Cross-section area,

$A = 5 \text{ cm}^2 = 5 \times 10^{-4} \text{ m}^2$

Core length, $l = 25 \text{ cm} = 25 \times 10^{-2}$ m

Now, Reluctance $= \dfrac{l}{\mu_0 \mu_r A}$

$$= \frac{25 \times 10^{-2}}{4\pi \times 10^{-7} \times 50 \times 5 \times 10^{-4}}$$

Also, $\text{Flux} = \dfrac{\text{mmf}}{\text{Reluctance}}$

POWER SYSTEMS

OBJECTIVE PRACTICE SETS

Page No. 132 - 252

1 CHAPTER
Performance of Transmission Lines, Line Parameters & Corona

MCQ and NAT Questions

Q.1 Use of bundled conductor increases,
(a) GMR
(b) GMD
(c) Potential gradient
(d) Radius of conductor

Q.2 ACSR conductor have
(a) all conductors made of aluminium
(b) outer conductors made of aluminium
(c) inner conductor made of aluminium
(d) core made of aluminium

Q.3 Regulation of a short transmission line is given by

(a) $\frac{|V_S|-|V_R|}{|V_R|}\times 100\%$ (b) $\frac{|V_R|-|V_S|}{|V_R^2|}\times 100\%$

(c) $\frac{|V_S|-|V_R|}{|V_R^2|}\times 100\%$ (d) $\frac{|V_S|-|V_R|}{|V_S|}\times 100\%$

Q.4 If the p.f. of load decrease, the line losses,
(a) increase (b) decrease
(c) remain same (d) none

Q.5 In a transmission line sag depends upon
(a) conductor material
(b) tension in conductor
(c) weight per unit length of conductor
(d) all the above

Q.6 For a 500 Hz frequency excitation, a 50 km long power line will be modelled as
(a) short line
(b) medium line
(c) long line
(d) data insufficient for decision

Q.7 The good effect of corona on overhead lines is to
(a) increase the line carrying capacity due to conducting ionised air envelop around the conductor.
(b) increase the power factor due to corona loss.
(c) reduce the radio interference from the conductor.
(d) reduce the steepness of surge fronts.

Q.8 A 3-phase transmission line has its conductors at the corners of an equilateral triangle with side 3 m. The diameter of each conductor is 1.63 cm. The inductance of the line per phase per km is
(a) 1.232 mH (b) 1.182 mH
(c) 1.093 mH (d) 1.043 mH

Q.9 The capacitance of an overhead transmission line increases with
1. increase in mutual geometrical mean distance.
2. increase in height of conductors above ground.

Select the correct answer from the following:
(a) Both 1 and 2 are true
(b) Both 1 and 2 are false
(c) Only 1 is true
(d) Only 2 is true

Q.10 Which one of the following statement is correct? Corona loss increases with
(a) decrease in conductor size and increase in supply frequency.
(b) increase in both conductor size and supply frequency.
(c) decrease in both conductor size and supply frequency.
(d) increase in conductor size and decrease in supply frequency.

Q.11 What is the approximate value of the surge impedance loading of a 400 kV, 3-phase 50 Hz overhead single circuit transmission line?
(a) 230 MW (b) 400 MW
(c) 1000 MW (d) 1600 MW

Q.12 If a fixed amount of power is to be transmitted over certain length with fixed power loss, it can be said that volume of conductor is

(a) Inversely proportional to magnitude of the voltage and that of power factor of the load
(b) Inversely proportional to square of the voltage and square of power factor of the load
(c) Proportional to square of voltage and that of power factor of the load
(d) Proportional to magnitude of the voltage only

Q.13 The skin effect in a transmission line is affected by
(a) the resistivity of the transmission line
(b) the current magnitude in the transmission line
(c) the length of the transmission line
(d) the voltage applied across the transmission line

Q.14 When bundle of conductors are used in place of single conductors the effective inductance and capacitance will, respectively
(a) Increase and decrease
(b) Decrease and increase
(c) Decrease and remain unaffected
(d) Increase and remain unaffected

Q.15 Consider the following statements regarding corona:
1. It causes radio interference.
2. It attenuates lightning surges.
3. It causes power loss.
4. It is more prevalent in the middle conductor of a transmission line employing flat conductor configuration.

Which of the above statements are correct?
(a) 1, 2 and 3 only (b) 1, 2 and 4 only
(c) 1, 2, 3 and 4 (d) 3 and 4 only

Q.16 The transmission efficiency increases with
(a) decrease in pf and increase in voltage level
(b) decrease in pf and decrease in voltage level
(c) increase in pf and increase in voltage level
(d) increase in pf and decrease in voltage level

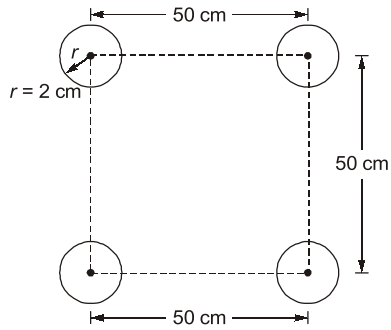
Q.17 A short line with reactance of 20 Ω and negligible resistance operates with a sending end voltage of 132 kV and a receiving end voltage of 126 kV. The maximum power that can be transmitted with this voltage profile is
(a) 400 MW (b) 832 MW
(c) 1000 MW (d) 132 MW

Q.18 The surge impedance of a 100 km line is 390 Ω. If the line is extended to 200 km, the value of surge impedance is
(a) 195 Ω
(b) 780 Ω
(c) depends on operating frequency
(d) 390 Ω

Q.19 Proximity effect depends upon
(a) size of the conductor
(b) resistivity of material
(c) permeability of the material
(d) all of the above

Q.20 In a short line, maximum power transfer occurs when δ is (here θ is angle of impedance of the line and δ = power angle):
(a) $> \theta$ (b) $= \theta$
(c) $< \theta$ (d) $= 90$

Q.21 A composite conductor consists of 4 conductors of radius 2 cm each. The conductors are arranged as shown below. The geometric mean radius GMR (in cm) for the given arrangement is _____ .



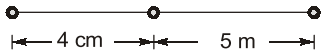
Q.22 For equilateral spacing of conductors of an untransposed 3-phase line, we have
(a) balanced receiving end voltage and no communication interference.
(b) unbalanced receiving end voltage and no communication interference.
(c) balanced receiving end voltage and communication interference.
(d) unbalanced receiving end voltage and communication interference.

Q.23 The time taken for a square wave to travel a 600 km long overhead transmission line is
(a) 6 sec (b) 1 sec
(c) 0.02 sec (d) 0.002 sec

Q.24 A cable has the following characteristics.
L = 0.201 μH/m and C = 196.2 pF/m
The velocity of wave propagation through the cable is

(d) GMD when conductors are horizontally spaced having spacing of 10 cm between them is 10 cm.

Q.70 A 3 phase, 50 Hz, 33 kV overhead line conductors are placed in a configuration as shown below. The conductor diameter is 1.5 cm. If the line length is 100 km, then



(a) capacitance per phase is 0.52 μF.
(b) capacitance per phase is 0.84 μF.
(c) charging current per phase is 12.1 A.
(d) charging current per phase is 5.028 A.

Q.71 A overhead 3 phase line delivers 10 MW at 33 kV at 0.6 pf (lagging). If the resistance and reactance of each conductor is 3 Ω and 5 Ω respectively, then
(a) sending end line voltage is 20.74 kV
(b) percentage regulation is 4.61%.
(c) transmission efficiency is about 93%.
(d) line current is 291.6 A.

■■■■

Answers — Performance of Transmission Lines, Line Parameters & Corona

1. (a)	2. (b)	3. (a)	4. (a)	5. (d)	6. (c)	7. (d)	8. (a)
9. (b)	10. (a)	11. (b)	12. (b)	13. (a)	14. (b)	15. (c)	16. (c)
17. (b)	18. (d)	19. (d)	20. (b)	21. (22.9)	22. (c)	23. (d)	24. (b)
25. (c)	26. (c)	27. (b)	28. (c)	29. (b)	30. (a)	31. (d)	32. (d)
33. (c)	34. (c)	35. (b)	36. (c)	37. (a)	38. (b)	39. (d)	40. (d)
41. (d)	42. (d)	43. (c)	44. (a)	45. (a)	46. (c)	47. (a)	48. (c)
49. (c)	50. (6.35)	51. (4000)	52. (191)	53. (296)	54. (0.80)	55. (–0.33)	56. (22.22)
57. (1.028)	58. (14)	59. (0)	60. (145.51)	61. (800)	62. (13.63)	63. (79.81)	
64. (110.71)	65. (95.62)	66. (b,c)	67. (a,b,d)	68. (b,c,d)	69. (a,c)	70. (b,d)	71. (c,d)

Explanations — Performance of Transmission Lines, Line Parameters & Corona

1. (a)

With the use of bundle conductors self GMD or GMR is increased which reduces the inductance of line.

2. (b)

ACSR is Aluminium conductor steel reinforced. In this the outer conductors made of aluminium.

3. (a)

$$\text{Voltage regulation } (V_R) = \frac{\left|\frac{V_S}{A}\right| - |V_R|}{|V_R|} \times 100\%$$

As for short line $\Rightarrow A = 1$

$$\therefore \quad (V_R) = \frac{|V_S| - |V_R|}{|V_R|} \times 100\%$$

4. (a)

$$\because \quad P = VI\cos\phi$$

$$I = \frac{P}{V\cos\phi}$$

For constant power and voltage, $I \propto \frac{1}{\cos\phi}$

$\therefore$ If p.f.↓ then I↑ and power loss↑.

$\because$ Power loss $(P_L) = I^2R$

5. (d)

$$\text{Sag} = \frac{WI^2}{8T}$$

where,
$W \rightarrow$ weight of conductor per unit length
$l \rightarrow$ span length
$T \rightarrow$ tension in conductor (depends on the conductor material)

6. (c)

Criteria to be full filled for
Short line $\Rightarrow l \cdot f < 4000$
Medium line $\Rightarrow 4000 < l \cdot f < 10000$
Long line $\Rightarrow l \cdot f > 10000$

7. (d)

Corona, is helpful in one respect, namely, it reduces the effect of surges and acts as a relief valve for them. This is so because the surges are partially dissipated as corona.

8. (a)

Radius of the conductor,

$$r = \frac{1.63}{2} = 0.815 \text{ cm}$$

$$r' = 0.7788 \times r$$
$$= 0.7788 \times 0.815 \text{ cm}$$
$$= 0.634 \text{ cm}$$
$$r' = 0.634 \times 10^{-2} \text{ m}$$

$$L = 2 \times 10^{-7} ln\left(\frac{D}{r'}\right) \text{H/meter/phase}$$

$$= 2 \times 10^{-7} ln\left(\frac{3}{0.634 \times 10^{-2}}\right)$$
$$= 12.32 \times 10^{-7} \text{ H/phase/meter}$$
$$= 1.232 \text{ mH/phase/km}$$

9. (b)

Capacitance of transmission line including earth field,

$$C = \frac{\pi \varepsilon_0 \varepsilon_r}{\ln\left(\frac{d}{r\sqrt{1+\frac{d^2}{4h^2}}}\right)}$$

From the above relationship,

- capacitance decreases with increase in mutual geometrical mean distance.
- capacitance decreases with increase in height of conductors above ground.

10. (a)

Corona loss,

$$P = 2.41 \times 10^{-5} \frac{(f+25)}{8} \sqrt{\frac{r}{d}} (V_P - V_0)^2$$

So, corona loss increases with frequency but V_0 is approximately directly proportional to conductor size. Therefore, as the conductor size increases, corona loss decreases.

11. (b)

$$\text{SIL} = \frac{(kV_L)^2}{Z_0} \text{ MW}$$

For single-circuit line,

$$Z_0 = 400 \ \Omega\text{/phase}$$

$$\therefore \quad \text{SIL} = \frac{400 \times 400}{400} = 400 \text{ MW}$$

12. (b)

$$R = \frac{\rho l}{a}$$

$$R \propto \frac{1}{a}$$

$$V_{01} = al$$

$$V_{01} \propto a$$

$$\Rightarrow \quad V_{01} \propto \frac{1}{R}$$

$$I_1^2 R_1 = I_2^2 R_2$$

$$\frac{I_1^2}{I_2^2} = \frac{R_2}{R_1}$$

$$\frac{I_1^2}{I_2^2} = \frac{V_{01}}{V_{02}} \qquad \ldots(i)$$

$$P = V_1 I_1 \cos\phi_1 = V_2 I_2 \cos\phi_2$$

$$\frac{I_1}{I_2} = \frac{V_2 \cos\phi_2}{V_1 \cos\phi_1} \qquad \ldots(ii)$$

Equation (ii) in equation (i),

$$\frac{(V_2 \cos\phi_2)^2}{(V_1 \cos\phi_1)^2} = \frac{\text{Vol}_1}{\text{Vol}_2}$$

$$\text{Volume of the conductor} \propto \frac{1}{(V \cos\phi)^2}$$

13. (a)

$$\because \quad \text{Skin depth}(\delta) = \frac{1}{\sqrt{\pi f \mu_0 \mu_r \sigma}} \propto \frac{1}{(\text{skin effect})}$$

$$\because \quad \sigma = \frac{1}{\rho}$$

Therefore skin effect is affected by resistivity of conductor.

14. (b)

For bundled conductors:

$$L_{ph} = 2 \times 10^{-7} \ln\left(\frac{D_m}{D_s}\right)$$

POWER ELECTRONICS

OBJECTIVE PRACTICE SETS

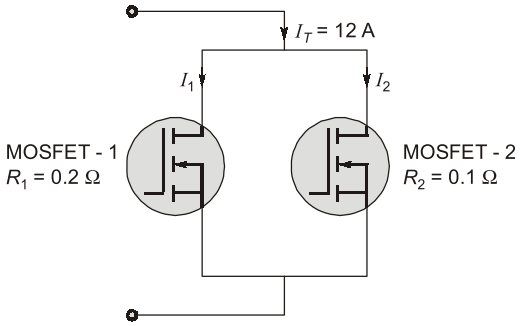
1 CHAPTER
Power Semiconductor Diode and Transistor

MCQ and NAT Questions

Q.1 The correct sequence of the among semiconductor devices is (decreasing order) of speed
(a) Power BJT, Power MOSFET, IGBT, SCR
(b) IGBT, Power MOSFET, Power BJT, SCR
(c) SCR, Power BJT, IGBT, MOSFET
(d) MOSFET, IGBT, Power BJT, SCR

Q.2 Turn-on and turn-off times of transistor depend on
(a) static characteristic
(b) junction capacitances
(c) current gain
(d) none of the above

Q.3 The power loss in MOSFET-1 and MOSFET-2 for the circuit shown below are respectively



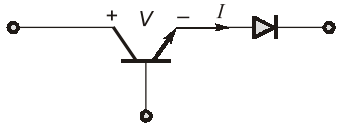
(a) 6.4 W and 3.2 W (b) 2.8 W and 7.2 W
(c) 3.2 W and 6.4 W (d) 7.2 W and 2.8 W

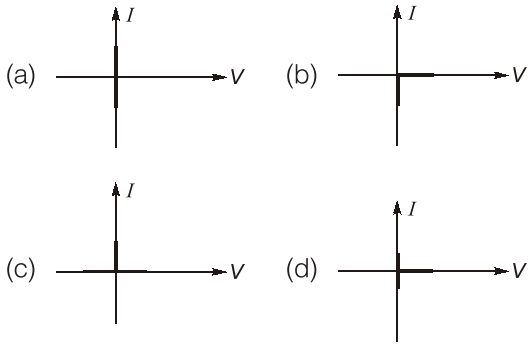
Q.4 A diode and a FET is anti-parallel combination blocks:
(a) Bidirectional voltage of passes unidirectional current.
(b) Bidirectional voltage and passes bidirectional current.
(c) Unidirectional voltage and passes unidirectional current.
(d) Unidirectional voltage and passes bidirectional current.

Q.5 For MOSFET:
(a) they are easy for parallel connection for higher current.
(b) leakage current is relatively high.
(c) have more linear characteristics.
(d) overload and perk current handling capability are high.

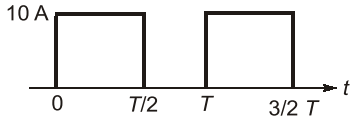
Q.6 For which transistor the symmetry is obtained as the emitter and collector or source and drain can be interchanged?
(a) BJT (b) IGBT
(c) SCR (d) MOSFET

Q.7 The V-I characteristics for the switch shown is (Devices are ideal)





Q.8 A MOSFET rated for 20 A, carries a periodic current as shown in the figure. The on-state resistance of the MOSFET is 0.2 ohm. What is the average on-state power loss of device per cycle?

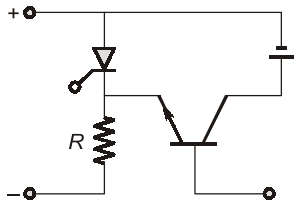


(a) 20 W (b) 15 W
(c) 10 W (d) 5 W

Q.9 For a BJT as a power control switch by biasing it in the cut-off region (off state) or in the saturation region (on state). In the on state, for the BJT (B-Base, E-Emitter, C-Collector)

(a) Both junctions are reverse biased.
(b) B-E junction reversed and B-C junction forward.
(c) B-E junction forward and B-C junction reversed.
(d) Both the base emitter and base-collector junctions are forward biased.

Q.10 For the shown circuit the objective function of BJT is



(a) to given control signal to trigger SCR
(b) to make SCR on
(c) to make SCR off
(d) to amplify anode current

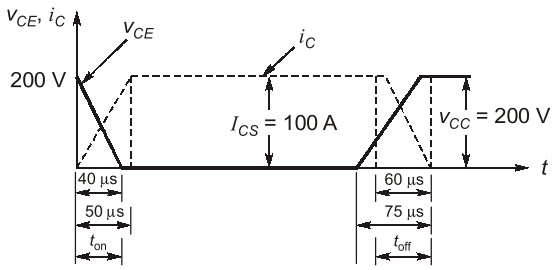
Q.11 Which one of the following does **not** exhibit negative resistance characteristic is

(d) FET (b) UJT
(c) Tunnel diode (d) SCR

Q.12 **Assertion (A):** MOSFETs have larger power handling capability in linear applications.
Reason (R): This can be attributed to their excellent thermal stability due to their positive temperature co-efficient.

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not a correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Q.13 A power transistor has its switching waveforms as shown in figure. If the average power loss in the transistor is limited to 300 W, the switching frequency at which the transistor can be operated is approximately equal to



(a) 0.98 kHz (b) 1.25 kHz
(c) 1.12 kHz (d) 1.65 kHz

Q.14 The reduction in the on-static voltage drop in IGBT is due to

(a) added Si layer in the IGBT structure
(b) conductivity modulation
(c) the *n*-drift layer
(d) all of the above

Q.15 Which device is used for current protection?

(a) the fuse (b) R-C network
(c) snubber network (d) none of these

Q.16 The conduction loss versus device current characteristic of a power MOSFET is best approximated by

(a) a parabola
(b) a straight line
(c) a rectangular hyperbola
(d) an exponentially decaying function

Q.17 Which one of the following is **not** a current triggered device?

(a) SCR (b) GTO
(c) TRIAC (d) MOSFET

Q.18 Power MOSFET has higher on state voltage drop than that of power BJT. Which one of the following reason is right?

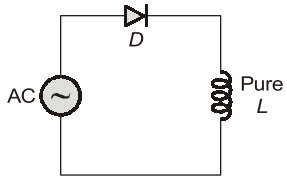
(a) Its current capacity is higher.
(b) It has no drift layer.
(c) Conductivity modulation is absent.
(d) It is a majority carrier device.

Q.19 The reverse recovery time of a diode is t_{rr} = 8 µsec and rate of fall of diode current with respect to time is 10 A/µsec. If the value of softness factor is 0.5, the reverse recovery charge stored will be ___ µC.

Q.20 **Statement (I):** The 'turn-on' and 'turn-off' time of a MOSFET is very small.
Statement (II): the MOSFET is a majority carrier device.

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

Q.21 In the circuit of adjacent figure the diode connects the ac source to a pure inductance *L*.



The diode conducts for

(a) 90° (b) 180°
(c) 270° (d) 360°

Q.22 In a power diode the rate of change of reverse current is 30 A/ms and charge involved in reverse recovery is 11 nC. The reverse recovery time for the diode will be _____ μsec.

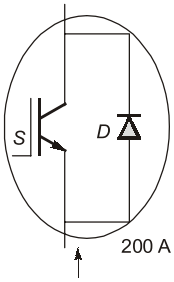
Q.23 Consider the following statements with regard to power diodes:

1. The breakdown voltage is directly proportional to the doping density of the drift region.
2. Losses in the diode are less due to conductivity modulation of the drift region in the on-state.
3. The vertically oriented structure supports large blocking voltages.

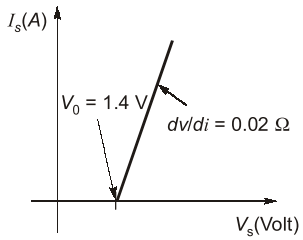
Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) 3 only (d) 1, 2 and 3

Q.24 A steady dc current of 200 A is flowing through a power module (*S*, *D*) as shown in Figure (a). The V-I characteristics of the IGBT (*S*) and the diode (*D*) are shown in Figures (b) and (c), respectively. The conduction power loss in the power module (*S*, *D*) is _____ W.

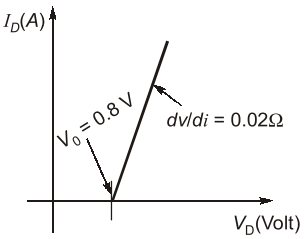


(a)



V-I characteristic of IGBT

(b)



V-I characteristic of diode

(c)

Q.25 For a diode, reverse recovery time is defined as the time between the diode current becomes zero and the instant reverse recovery current decays to

(a) 10% of reverse peak current I_{RM}
(b) 15% of I_{RM}
(c) zero
(d) 25% of I_{RM}

Q.26 The forward characteristics of a power diode can be represented by $V_f = 0.80 + 0.015\, i_f$. The average power loss and rms current for a constant current of 50 A for 2/3 of a cycle is x and y. Find x/y _____.

Q.27 The reverse recovery time of a diode is 3 μs and rate of fall $\left(\frac{di}{dt}\right)$ is 30 A/μs. The stored charge of the diode is

(a) 45 μC (b) 135 μC
(c) 270 μC (d) 540 μC

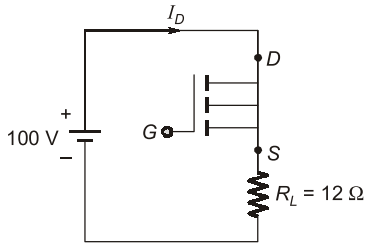
Q.28 Consider the following statements:

1. Power BJT is the fastest switching device.
2. The power electronic device that combines the characteristics of MOSFET and BJT is MCT.
3. Diac is two terminal bidirectional switch.

Which of the above statements is/are **not** correct?

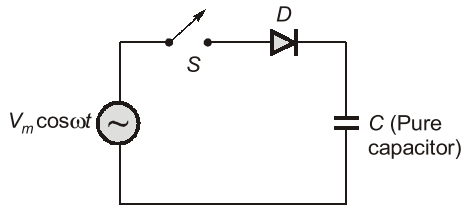
(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) all of the above

Q.29 For the circuit shown below, the power-loss in the on-state is (MOSFET parameters are: t_r = 2 μs, $R_{DS(on)}$ = 0.2 Ω, duty cycle D = 0.7 and f = 30 kHz)



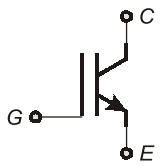
(a) 6.28 W (b) 9.41 W
(c) 5.00 W (d) 2.22 W

Q.30 In the circuits shown below,



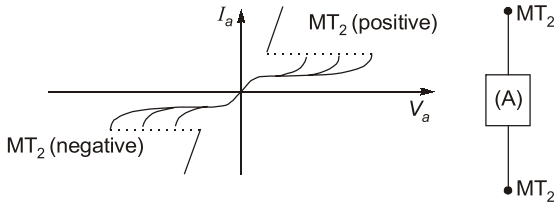
If switch in figure is closed at t = 0, then the diode '*D*' conducts for _____(degree).

Q.39 Which of the following option(s) is/are correct regarding the device whose symbol is shown below:

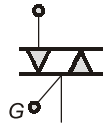


(a) The device is power MOSFET.
(b) The device is known as metal oxide insulated gate transistor.
(c) It has high input impedance.
(d) It has low on state power loss.

Q.40 The static VI characteristics of a device is shown. The correct option(s) regarding the device can be



(a) The device is UJT
(b) The device is bidirectional in nature.
(c) The block A can be



(d) The device is extensively used for heat control, speed control of single phase induction motors.

■■■■

Answers Power Semiconductor Diode and Transistor

1. (d)	2. (b)	3. (c)	4. (d)	5. (b)	6. (d)	7. (c)	8. (c)	9. (d)
10. (c)	11. (a)	12. (a)	13. (c)	14. (b)	15. (a)	16. (a)	17. (d)	18. (c)
19. (213.33)	20. (a)	21. (d)	22. (0.027)	23. (c)	24. (960)	25. (d)	26. (1.265)	27. (b)
28. (a)	29. (b)	30. (0)	31. (c)	32. (75)	33. (b)	34. (a)	35. (c)	36. (200)
37. (a,c)	38. (a,c)	39. (b,c,d)	40. (b,c,d)					

Explanations Power Semiconductor Diode and Transistor

1. (d)

MOSFET has the highest operating speed (frequency).

2. (b)

Turn-on and turn-off times of transistor depend on junction capacitance.

Because of charging and discharging of junction capacitance a transistor does not turn-on and turn off instantly.

3. (c)

During on state, MOSFET can be replaced resistors.

∴ Using current divider rule,

$$I_1 = \left(\frac{R_2}{R_1 + R_2}\right) I_T$$

or $$I_1 = \left(\frac{0.1}{0.3}\right) \times 12 = 4 \text{ A}$$

and $$I_2 = I_T - I_1 = 12 - 4 = 8 \text{ A}$$

∴ $$P_1 = I_1^2 \cdot R_1 = 4^2 \times 0.2 = 3.2 \text{ W}$$

and $$P_2 = I_2^2 \cdot R_2 = 8^2 \times 0.1 = 6.4 \text{ W}$$

4. (d)

If device has one antiparallel diode, entire circuit allows the bidirectional current and at the same time it blocks the unidirectional voltage.

5. (b)

Leakage current is relatively high.

6. (d)

MOSFET has this symmetry.

7. (c)

Because of diode current can never be negative. When current flows the voltage across the switch is zero and if current is zero then these may be any voltage across the switch.

8. (c)

$$P_{avg.} = I_{rms}^2 \cdot R_{ON}$$

$$R_{ON} = 0.2\ \Omega$$

$$I_{rms} = \sqrt{\frac{1}{T}\int_0^{T/2} (10)^2\, dt} = \sqrt{50}\ \text{A}$$

$$P_{avg.} = (\sqrt{50})^2(0.2) = 10\ \text{W}$$

9. (d)

In the ON state of BJT (being used as a power control switch) both base emitter and base collector junction are forward biased.

10. (c)

In the given circuit, objective function of BST is commutation of SCR.

11. (a)

FET's do not exhibit negative resistance characteristics

12. (a)

MOSFET has positive temperature coefficient which avoid problem of thermal runaway. Also MOSFET parallel operation is easy.

13. (c)

Energy loss during turn-on $= \int_0^{t_{on}} i_c \cdot v_{CE}\, dt$

$$= \int_0^{t_{on}} \left(\frac{I_{CS}}{50} \times 10^6 t\right)\left(V_{CC} - \frac{V_{CC}}{40} \times 10^6 t\right) dt$$

$$= \int_0^{t_{on}} (2 \times 10^6 t)(200 - 5 \times 10^6 t) dt$$

$= 0.1067$ Watt-sec

Energy loss during turn-off

$$= \int_0^{t_{off}} \left(100 - \frac{100}{60} \times 10^6 t\right) \times \left(\frac{200}{75} \times 10^6 t\right) dt$$

$= 0.1603$ Watt-sec

Total energy loss in one cycle

$= 0.1067 + 0.1603$

$= 0.267$ W-sec

Average power loss in transistor

= Switching frequency × energy loss in one cycle

∴ Allowable switching frequency

$$f = \frac{300}{0.267} = 1123.6\ \text{Hz} \approx 1.12\ \text{kHz}$$

14. (b)

The reduction in the ON stage static voltage drop in IGBT as compared to MOSFET's is due to the conductivity modulation phenomenon.

15. (a)

Generally, fuses are used for over current protection of the devices.

16. (a)

Let, I = device current

R_{ON} = ON state resistance of power MOSFET

Conduction loss

$= P = I^2 R_{ON}$

Therefore, condition losses versus device current characteristics can be best approximated by a parabola.

17. (d)

MOSFET is a voltage controlled device device whereas SCR, GTO, TRIAC all belong to thyristor family are current controlled devices.

18. (c)

Power MOSFET has higher ON state voltage drop as compared to power BJT because of absence of conductivity modulation.

19. Sol.