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CONTENTS

ELECTRONICS ENGINEERING

Objective Practice Sets

Basic Electrical Engineering

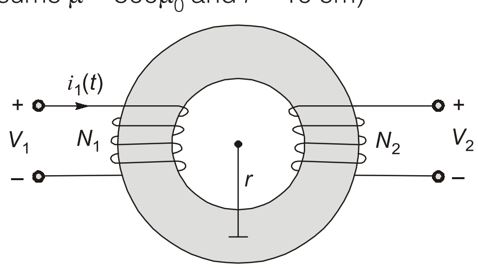
1 CHAPTER Electromagnetism and DC Machines

Q.1 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. The magnetic energy stored in the coil is
(a) 0.25 J (b) 0.5 J
(c) 1 J (d) 2 J

Q.2 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 A/m and 397.9
(b) 300 A/m and 500×10^{-6}
(c) 300 A/m and 397.9
(d) 1200 A/m and 500×10^{-6}

Q.3 An ideal transformer has N_1 = 100 turns and N_2 = 200 turns with a mutual flux of $\phi_m(t) = -0.05(t^2 - 2t)$. The induced emf of secondary is
(a) $5(t - 1)$ V (b) $10(t - 1)$ V
(c) $5(t^2 - 1)$ V (d) $20(t - 1)$ V

Q.4 The magnetic circuit shown below has a uniform cross section of 10^{-3} m^2. If the circuit is energized by a current $i_1(t) = 3\sin 100\pi t$ A in the coil of N_1 = 200 turns, then the emf induced in the coil of N_2 = 100 turns will be
(Assume $\mu = 500\mu_0$ and r = 10 cm)



(a) $\frac{3\pi}{\sqrt{2}}\cos 100\pi t$ V (b) $-6\pi\cos 100\pi t$ V
(c) $4\pi\sin 100\pi t$ V (d) $-3\pi\cos 100\pi t$ V

Q.5 In a dc motor the windage loss is proportional to
(a) supply voltage
(b) square of the supply voltage
(c) square of the flux density
(d) square of the armature speed

Q.6 Wave winding is employed in a d.c. machine of
(a) high current and low voltage rating
(b) low current and high voltage rating
(c) high current and high voltage rating
(d) low current and low voltage rating

Q.7 The emf induced in each conductor of the armature in a dc machine is
(a) alternating in nature
(b) direct in nature
(c) pulsating in nature
(d) has a random waveshape

Q.8 For a P-pole machine, the relation between electrical and mechanical degrees is
(a) $\theta_{elec} = \frac{2}{P}\theta_{mech}$ (b) $\theta_{elec} = \frac{4}{P}\theta_{mech}$
(c) $\theta_{elec} = \theta_{mech}$ (d) $\theta_{elec} = \frac{P}{2}\theta_{mech}$

Q.9 The commutator of the dc motor serves the purpose of
(a) changing ac to dc
(b) changing dc to ac
(c) reducing friction
(d) avoiding sparking at the crushes

Q.10 In dc machines, the field-flux axis and armature-mmf axis are respectively along
(a) direct axis and indirect axis
(b) direct axis and inter-polar axis
(c) quadrature axis and direct axis
(d) quadrature axis and inter-polar axis

Q.11 Normally a large number of commutator segments are used in a dc generator to
(a) increase the magnitude of the output voltage
(b) increase the output current
(c) increase the kW power output
(d) make the dc output more smooth

Q.12 The armature resistance of a 6-pole lap wound d.c. machine is 0.05 Ω. If the armature is rewound as a wave-winding, what is the armature resistance?
(a) 0.45 Ω (b) 0.30 Ω
(c) 0.15 Ω (d) 0.10 Ω

Q.13 Which of the following windings are necessary in case of all dc machines?
(a) lap winding (b) wave winding
(c) closed coil winding (d) open coil winding

Q.14 In a dc machine, the constant losses are
(a) armature copper loss
(b) shunt field copper loss
(c) iron and mechanical loss
(d) (b) and (c) both

Q.15 The function(s) of pole shoes in a dc machine is/are to
(a) support the field coils.
(b) reduce the reluctance of the magnetic path.
(c) spread out the flux to achieve uniform flux distribution in the air gap.
(d) all of the above.

Q.16 In a dc machine mechanical losses occur due to
(a) air resistance of rotation to armature and fan
(b) brush friction
(c) bearing friction
(d) all the above

Q.17 In a dc motor if the brushes are shifted opposite to its direction of rotation, then
(a) commutation is worsened and speed decreases.
(b) commutation is improved and speed decreases.
(c) commutation is worsened and speed increase.
(d) commutation is improved and speed increase.

Q.18 The field coils of a dc generator are usually made of
(a) mica (b) copper
(c) cast iron (d) carbon

Q.19 Consider the following statements and choose the correct option:
1. Slot wedges in a DC machine made of silicon steel.
2. In a DC machine armature is stationary, yoke rotates.
3. The air gap between the yoke and armature in a DC motor is kept small in order to achieve a stronger magnetic field.
(a) Only statement 2 is correct
(b) Only statements 1 and 2 are incorrect
(c) Only statements 2 and 3 are incorrect
(d) All statements are correct

Q.20 Consider the following statements in respect of compensating windings in dc motors:
1. Compensating windings are connected in series with the armature.
2. Compensating windings aid commutation.
3. Compensating windings produce mmf in the same direction as that of armature mmf.
Which of these statements is/are correct?
(a) 2 and 3 (b) Only 1
(c) 1 and 3 (d) 1 and 2

Q.21 Determine the flux per pole for 6-pole dc machine having 240 wave connected conductors, which generates an open circuit voltage of 500 volt, which is running at 1000 rpm.
(a) 0.129 Wb (b) 0.021 Wb
(c) 0.042 Wb (d) 7 mWb

Q.22 An eight pole d.c. generator has a simple wave wound armature containing 32 coils of 6 turns each. Its flux per pole is 0.06 Wb. The machine is running at 250 rpm. The induced armature voltage is
(a) 96 V (b) 192 V
(c) 384 V (d) 768 V

Q.23 Consider the following parts of a dc machine:
1. Yoke 2. Armature core
3. Brushes 4. Pole core
Which of the above parts are subjected to iron loss?
(a) 1 and 2 only (b) 2 only
(c) 1 only (d) 1, 2, 3 and 4

Q.24 A triangular mmf wave is produced in the air-gap of an electric machine. Such a wave is produced by
(a) stator of an induction machine
(b) rotor of a synchronous machine
(c) stator of a dc machine
(d) rotor of a dc machine

Codes:

	A	B	C
(a)	1	2	3
(b)	2	3	1
(c)	3	1	2
(d)	3	2	1

Q.74 Match **List-I** (Types of electrical loads) with **List-II** (Torque-speed characteristics) and select the correct answer:

List-I
A. Hoist
B. Fans
C. Machine Tools (Lathe, Milling machine etc)
D. Loads with fluid friction

List-II
1. Torque ∝ $(\text{speed})^2$
2. Torque ∝ (speed)
3. Constant Torque
4. Torque ∝ 1/(speed)

Codes:

	A	B	C	D
(a)	1	3	2	4
(b)	1	3	4	2
(c)	4	1	3	2
(d)	3	1	2	4

Q.75 **Statement (I):** DC series motors are used in electric locomotives, cranes, etc.
Statement (II): DC series motors provide high starting torque.
(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are true but Statement (II) is not a 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.

■■■■

Answers Electromagnetism and DC Machines

1. (b)	**2.** (a)	**3.** (d)	**4.** (b)	**5.** (d)	**6.** (b)	**7.** (a)	**8.** (d)	**9.** (b)
10. (b)	**11.** (d)	**12.** (a)	**13.** (c)	**14.** (d)	**15.** (d)	**16.** (d)	**17.** (d)	**18.** (b)
19. (a)	**20.** (d)	**21.** (c)	**22.** (c)	**23.** (b)	**24.** (d)	**25.** (c)	**26.** (c)	**27.** (a)
28. (a)	**29.** (d)	**30.** (c)	**31.** (b)	**32.** (c)	**33.** (c)	**34.** (c)	**35.** (b)	**36.** (b)
37. (b)	**38.** (a)	**39.** (a)	**40.** (b)	**41.** (d)	**42.** (a)	**43.** (c)	**44.** (c)	**45.** (a)
46. (c)	**47.** (c)	**48.** (b)	**49.** (a)	**50.** (c)	**51.** (d)	**52.** (b)	**53.** (c)	**54.** (c)
55. (a)	**56.** (a)	**57.** (c)	**58.** (a)	**59.** (d)	**60.** (a)	**61.** (a)	**62.** (b)	**63.** (a)
64. (a)	**65.** (d)	**66.** (d)	**67.** (c)	**68.** (a)	**69.** (b)	**70.** (d)	**71.** (c)	**72.** (d)
73. (b)	**74.** (c)	**75.** (a)						

Explanations Electromagnetism and DC Machines

1. (b)

$$N\phi = Li$$

$$E = \frac{1}{2}Li^2 = \frac{1}{2}\left(\frac{N\phi}{i}\right)i^2$$

$$= \frac{1}{2}\times 1000\times 10^{-3}\times 1 = \frac{1}{2}J$$

2. (a)

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

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

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

3. (d)

Induced emf in secondary coil $= -N_2\dfrac{d\phi_m}{dt}$

$$= -200\frac{d}{dt}[-0.05(t^2-2t)]$$

$$= 10\frac{d}{dt}(t^2-2t) = 10(2t-2)$$

$$= 20(t-1)$$

4. (b)

The magnetic flux in the circuit,

$$\phi_1 = \frac{N_1I_1}{S_1} = \frac{N_1I_1}{l/\mu A} = \frac{N_1I_1\mu A}{2\pi r}$$

where, S_1 = Magnetic reluctance

According to Faraday's law, the emf induced in the second coil is

$$e_2 = -N_2\frac{d\phi}{dt}$$

$$e_2 = \frac{-100\times 200\times 500\times 4\pi\times 10^{-7}\times 10^{-3}}{2\pi\times 10\times 10^{-2}}\frac{dI_1(t)}{dt}$$

$$= -\frac{1}{50}\frac{d}{dt}(3\sin 100\pi t)$$

$$= -6\pi\cos 100\pi t \text{ V}$$

5. (d)

Windage loss $\propto$ (armature speed)^2

6. (b)

Wave winding: Low current and high voltage rating.

Lap winding: High current and low voltage rating.

7. (a)

EMF induced is alternating in nature.

8. (d)

One mechanical rotation covers $P/2$ electrical cycles

$$\theta_{elec} = \frac{P}{2}\theta_{mech}$$

9. (b)

DC motor is supplied with dc power at its terminal which is converted in ac with help of commutator for motor operation.

10. (b)

Field flux axis and armature axis are respectively along direct axis and inter-polar axis.

11. (d)

To make DC output more smooth.

12. (a)

In lap winding no. of parallel paths $A = P = 6$

$\therefore$ Resistance of single path R is given by

$$\frac{R}{6} = 0.05 \Rightarrow R = 0.30\ \Omega$$

In wave winding $A = 2$, so single path would have resistance of $3R$.

$$\therefore \text{ armature resistance} = \frac{3R}{2} = \frac{3}{2}\times 0.3 = 0.45\ \Omega$$

13. (c)

In case of all dc machines we must use closed winding. Lap and wave windings are used based on requirement of high current, low voltage and high voltage, low current but winding of all dc machines is closed winding. It is never short pitched. Open coil winding is usually employed in ac machines.

14. (d)

Constant losses = Iron losses
Mechanical losses
Shunt field Cu loss

15. (d)

All the statements are correct.

16. (d)

Mechanical are due to: Brush friction, Bearing friction and air resistance of rotation.

17. (d)

The distortion of flux is in a direction opposite to the direction of rotation of motor. So brush is shifted in a direction opposite to motor rotation.

$$E_a = K_a \phi \omega_m$$

$$\omega_m = \frac{E_a}{K_a \phi}$$

with brush shift resultant flux get reduced. So speed of motor increases.

18. (b)

Field coils must be of good conductor hence Cu is used.

19. (a)

In DC machine armature rotates while yoke is stationary.

20. (d)

Compensating winding (Cw) aid commutation in pole shoe area. Cw are connected in series to armature winding to provide the support as per the severity of armature reaction.

21. (c)

$$E = \frac{PN\phi Z}{60\ A}$$

$$500 = \frac{6 \times 1000 \times 240 \times \phi}{60 \times 2}$$

$$\phi = \frac{1}{24} = 0.042 \text{ Wb}$$

22. (c)

Number of coils = 32, each coil has 6 turns and each turn has two conductors.

Total number of conductors,

$$Z = 32 \times 6 \times 2 = 384$$

Induced armature voltage

$$= \left(\frac{\phi Z N}{60}\right)\left(\frac{P}{A}\right)$$

$$= \frac{0.06 \times 384 \times 250}{60} \times \frac{8}{2} = 384 \text{ V}$$

[For wave winding A = 2].

23. (b)

In DC machine iron losses is in armature core only, other parts of machine carry constant steady flux, so no iron losses.

24. (d)

In dc machine, armature winding is placed in rotor and it has triangular armature mmf.

25. (c)

Average emf induced in each conductor in each parallel path is equal but not instantaneous emf in each conductor of each parallel path.

26. (c)

$$\frac{V}{f} \propto \phi = \text{constant}$$

$$P_h \propto Af \propto A \times 2000$$

$$\Rightarrow \quad A = \frac{500}{2000} = \frac{1}{4}$$

and $P_e \propto f^2$

$$\Rightarrow \quad P_e = Bf^2$$

$$\Rightarrow \quad B = \frac{200}{(2000)^2} = \frac{1}{20000}$$

$$P_i = Af + Bf^2$$

$$= \frac{1}{4} \times 1000 + \frac{1}{20000} \times (1000)^2$$

$$P_i = 250 + 50 = 300 \text{ Watt}$$

27. (a)

Back emf, $E_b = 0$ at starting.

28. (a)

Constant power,

$$V_{t_1} I_{a_1} = V_{t_2} I_{a_2}$$

$$(1.0)(1.0) = (0.5)(I_{a_2}) \Rightarrow I_{a_2} = 2.0 \text{ p.u.}$$

$$V_{t_1} = K_a \phi \omega_{m_1}$$

($V_t = E_a + I_a r_a$, $r_a \rightarrow$ neglected, so $V_t = E_a$)

$$\frac{V_{t_1}}{V_{t_2}} = \frac{n_1}{n_2} = \frac{1}{0.5}$$

$$\Rightarrow \quad n_2 = 0.5\ n_1 = 0.5 \text{ p.u.}$$