Physics · Electric Current and Electromagnetism · Electromagnetic Induction

The Electric Generator

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Multiple choice questions — 113 questions

1 The direction of the electric current generated in the coil of a dynamo can be found using .....

(A) Fleming's left-hand rule
(B) Ampere's right-hand rule
(C) Fleming's right-hand rule
(D) the right-hand screw rule

2 The rate at which the dynamo coil cuts the magnetic flux lines is maximum when the plane of the coil is .....

(A) perpendicular to the flux lines
(B) parallel to the flux lines
(C) inclined at 30° to the flux lines
(D) inclined at 60° to the flux lines

3 The time rate of cutting magnetic flux lines by the dynamo coil during its rotation is zero when the plane of the coil becomes .....

(A) inclined to the field at 45°
(B) parallel to the field
(C) perpendicular to the field
(D) inclined to the field at 30°

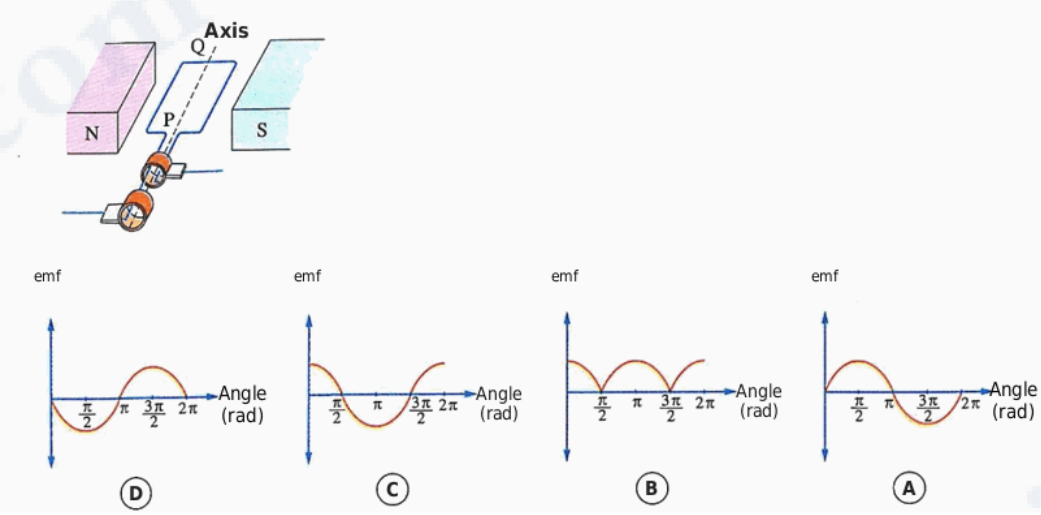
4 At the moment when the coil of an AC dynamo is parallel to the direction of the magnetic flux, the magnetic flux through the coil (φ_m) and the emf induced in the coil are .....

(A) φ_m: maximum, emf: zero
(B) φ_m: zero, emf: maximum
(C) φ_m: maximum, emf: maximum
(D) φ_m: zero, emf: zero

5 In an AC dynamo, when the maximum induced emf is obtained, the plane of the coil relative to the magnetic field is .....

(A) perpendicular (B) parallel (C) inclined at 45° (D) inclined at 60°

6 A rectangular coil rotates between two magnetic poles. If the coil rotates about the axis PQ starting from the position shown in the figure, which of the following graphs correctly represents the change of the induced emf in the coil during one complete revolution?



7 The coil of an AC dynamo rotates in a uniform magnetic field with an angular velocity ω. The periodic time of the coil is .....

(A) $(\omega)/(\pi)$ (B) $(2\pi)/(\omega)$ (C) $(\pi)/(\omega)$ (D) $(\omega)/2$

8 The coil of an AC dynamo rotates about an axis parallel to its length with an angular velocity of 377.2 rad/s. The frequency of the current is .....

(A) 50 Hz (B) 60 Hz (C) 75 Hz (D) 100 Hz

9 If the number of turns of the dynamo coil is doubled and its angular velocity (ω) is reduced to a quarter, the maximum emf generated by it .....

(A) doubles
(B) decreases to half
(C) stays constant
(D) decreases to a quarter

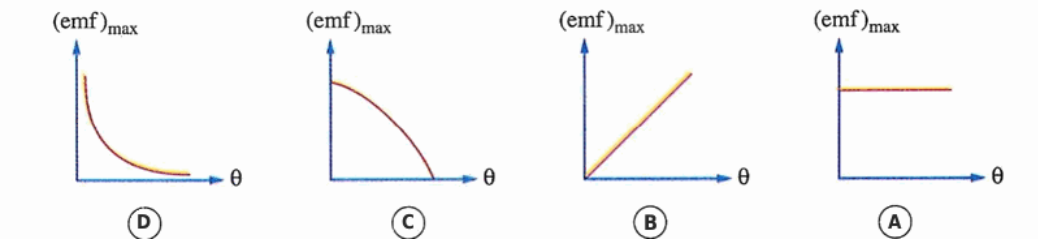
10 The coil of an electric generator rotates with an angular velocity of 281 rad/s, producing a maximum induced emf of 120 V. The angular velocity needed to produce a maximum induced emf of 480 V is .....

(A) 2.7 rad/s (B) 70.3 rad/s (C) 205 rad/s (D) 1124 rad/s

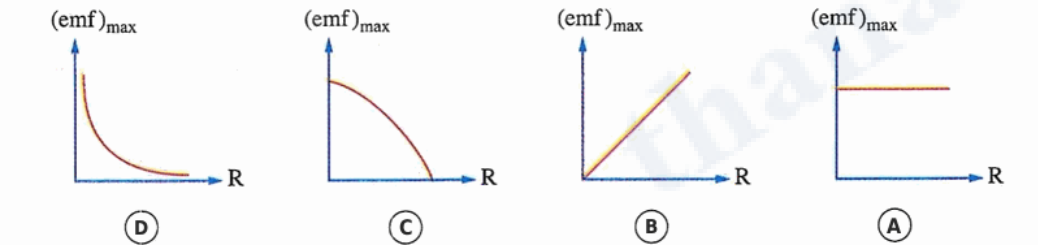
11 The $(emf)_{max}$ generated in a dynamo coil is 100 V when the coil rotates at a frequency (f). When the frequency is increased by 25 Hz, $(emf)_{max}$ increases to 150 V. The value of the frequency (f) is .....

(A) 25 Hz (B) 50 Hz (C) 100 Hz (D) 150 Hz

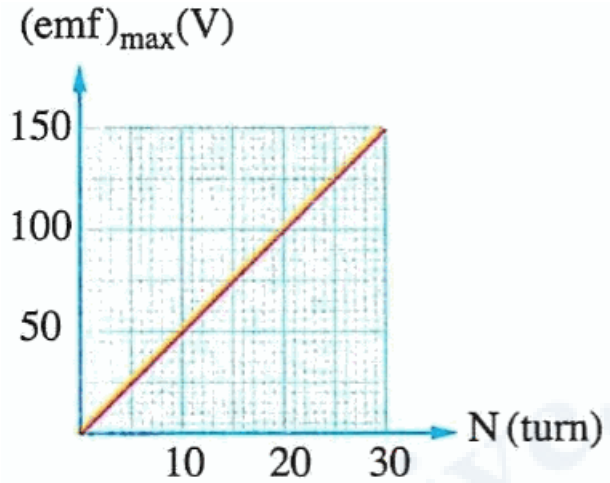
12 Which of the following graphs represents the relation between the maximum induced emf $(emf)_{max}$ generated in the dynamo coil and the angle of rotation of the coil (θ)?



13 Which of the following graphs represents the relation between the maximum induced emf $(emf)_{max}$ generated in the dynamo coil and the resistance of the dynamo coil (R)?

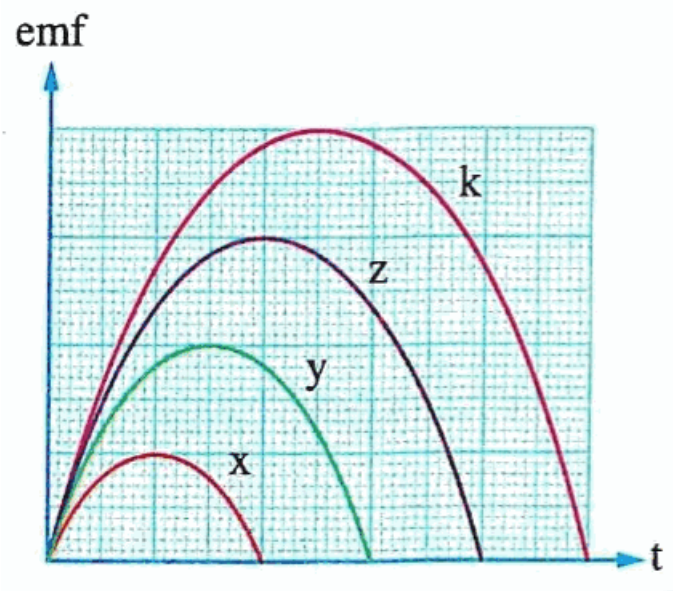


14 The opposite graph represents the relation between the maximum induced emf $(emf)_{max}$ in a dynamo coil whose number of turns can be changed and the number of turns of the coil (N). If the angular velocity of the coil is 100 rad/s and the magnetic flux density is 0.4 T, the area of the coil is .....



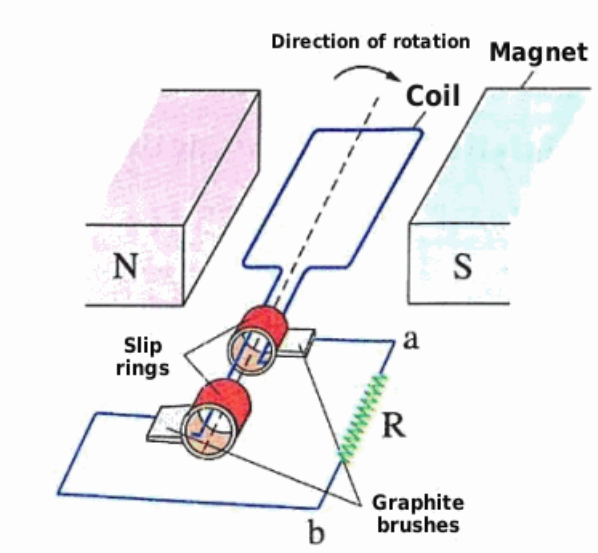
(A) 0.5 m^2 (B) 0.2 m^2 (C) 0.25 m^2 (D) 0.125 m^2

15 Four electric generators x, y, z and k have coils with the same number of turns and are affected by identical magnetic fields. The opposite graph represents the relation between the emf generated in the coil of each during half a revolution and the time (t). The relation between the face areas of these coils is .....



(A) $A_x > A_y > A_z > A_k$
(B) $A_x = A_y = A_z = A_k$
(C) $A_k > A_y > A_z > A_x$
(D) $A_k > A_z > A_y > A_x$

16 The opposite figure shows an electric generator whose coil has a cross-sectional area of 0.5 m^2 and 400 turns. If the coil rotates about the axis of rotation with an angular velocity of 10 π rad/s and the maximum induced emf in it is 628 V, then ..... (given: π = 3.14)



(A) the magnetic flux density acting on the coil: 0.01 T, the direction of the induced current in the external circuit at the moment shown: from a to b

(B) the magnetic flux density acting on the coil: 0.01 T, the direction of the induced current in the external circuit at the moment shown: from b to a

(C) the magnetic flux density acting on the coil: 0.1 T, the direction of the induced current in the external circuit at the moment shown: from a to b

(D) the magnetic flux density acting on the coil: 0.1 T, the direction of the induced current in the external circuit at the moment shown: from b to a

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17 The instantaneous induced emf in the dynamo coil is calculated from the relation $emf = NBA\omega \sin\theta$. Which of the following statements does NOT describe the angle θ in this relation correctly?

(A) θ is the angle between the normal to the direction of the magnetic field and the plane of the coil

(B) θ is the angle between the direction of the magnetic field and the normal to the plane of the coil

(C) θ is the angle between the direction of the magnetic field and the direction of the velocity of one side of the coil

(D) θ is the angle between the direction of the magnetic field and the plane of the coil

---

18 The instantaneous induced emf in the coil of an AC dynamo during its rotation, when the angle between the plane of the dynamo coil and the direction of the magnetic flux is:

(1) 60°, equals .....

(A) $(\sqrt{3})/2$ of its maximum value
(B) $1/2$ its maximum value
(C) its maximum value
(D) its effective value

---

19 The instantaneous induced emf in the coil of an AC dynamo during its rotation, when the angle between the plane of the dynamo coil and the direction of the magnetic flux is:

(2) 45°, equals .....

(A) $\sqrt{2}$ of its maximum value
(B) half its maximum value
(C) its maximum value
(D) its effective value

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20 If the maximum induced emf in a dynamo coil is 200 V, the instantaneous induced emf when:

(1) the coil reaches $1/12$ of a revolution from the moment when the emf is zero, is .....

(A) 50 V (B) 100 V (C) 150 V (D) 200 V

---

21 If the maximum induced emf in a dynamo coil is 200 V, the instantaneous induced emf when:

(2) the angle between the normal to the plane of the coil and the flux lines is 30°, is .....

(A) 50 V (B) 100 V (C) 150 V (D) 200 V

---

22 If the maximum induced emf in a dynamo coil is 200 V, the instantaneous induced emf when:

(3) the plane of the coil is inclined to the field at 60°, is .....

(A) 100 V (B) 70 V (C) 50 V (D) 20 V

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23 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of 6×10^{-2} m². It rotates in a magnetic field at 1800 revolutions per minute. If the magnetic flux density is 0.1 Tesla, then:

(1) The induced emf in the coil when it passes through the following positions:

(a) the plane of the coil perpendicular to the field equals .....

(A) 0 (B) 72 V (C) 144 V (D) 216 V

---

24 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of 6×10^{-2} m². It rotates in a magnetic field at 1800 revolutions per minute. If the magnetic flux density is 0.1 Tesla, then:

(1) The induced emf in the coil when it passes through the following positions:

(b) the plane of the coil parallel to the field equals .....

(A) 0 (B) 226.29 V (C) 452.58 V (D) 678.87 V

25 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of 6×10^{-2} m². It rotates in a magnetic field at 1800 revolutions per minute. If the magnetic flux density is 0.1 Tesla, then:

(1) The induced emf in the coil when it passes through the following positions:

(c) the plane of the coil inclined at 60° to the direction of the field equals .....

(A) 113.15 V (B) 144.5 V (C) 155.3 V (D) 169.2 V

26 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of 6×10^{-2} m². It rotates in a magnetic field at 1800 revolutions per minute. If the magnetic flux density is 0.1 Tesla, then:

(2) The average induced emf in the following cases:

(a) during a quarter of a revolution from the position perpendicular to the field equals .....

(A) 36 V (B) 72 V (C) 144 V (D) 288 V

27 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of 6×10^{-2} m². It rotates in a magnetic field at 1800 revolutions per minute. If the magnetic flux density is 0.1 Tesla, then:

(2) The average induced emf in the following cases:

(b) during half a revolution from the position perpendicular to the field equals .....

(A) 0 (B) 144 V (C) 288 V (D) 300 V

28 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of 6×10^{-2} m². It rotates in a magnetic field at 1800 revolutions per minute. If the magnetic flux density is 0.1 Tesla, then:

(2) The average induced emf in the following cases:

(c) during a complete revolution starting from the zero position equals .....

(A) 576 V (B) 144 V (C) 36 V (D) 0

29 The coil of an AC dynamo, of dimensions 5 cm and 10 cm and consisting of 420 turns, is placed in a uniform magnetic field of flux density 0.4 Tesla so that the plane of the coil is perpendicular to this field. If the coil rotates at 1000 revolutions per minute, the induced emf in each of the following positions:

(1) after $1/4$ of a revolution from the first position equals .....

(A) 22 V (B) 44 V (C) 66 V (D) 88 V

30 The coil of an AC dynamo, of dimensions 5 cm and 10 cm and consisting of 420 turns, is placed in a uniform magnetic field of flux density 0.4 Tesla so that the plane of the coil is perpendicular to this field. If the coil rotates at 1000 revolutions per minute, the induced emf in each of the following positions:

(2) after 150° from the first position equals .....

(A) 22 V (B) 44 V (C) 66 V (D) 88 V

31 A dynamo coil with a face area of 4×10^{-2} m² and 70 turns rotates at 3600 revolutions per minute in a magnetic field of flux density 0.5 Tesla. If it starts moving when its plane is perpendicular to the direction of the field, the emf after $1/720$ second from the start of the motion equals .....

(A) 132 V (B) 264 V (C) 276.6 V (D) 342.8 V

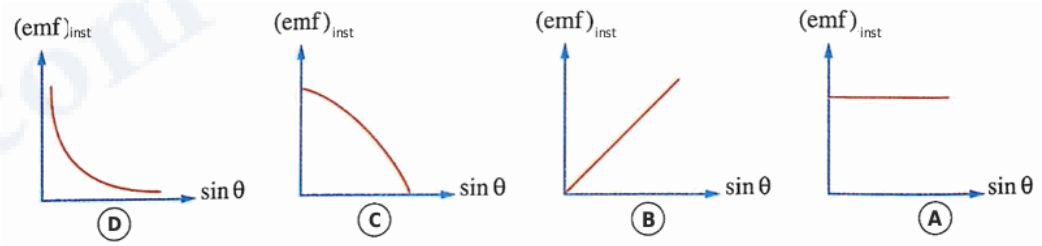
32 The coil of an electric generator consists of 600 turns, each of area 25 cm². If the coil is rotated about an axis perpendicular to a uniform magnetic flux of density B with a constant angular velocity (ω), an induced emf given by $emf = 12.5 \sin(100\,\pi\,t)$ is generated. The magnetic flux density (B) is approximately .....

(A) 2.7×10^{-6} T (B) 2.7×10^{-4} T (C) 2.7×10^{-2} T (D) 2.7 T

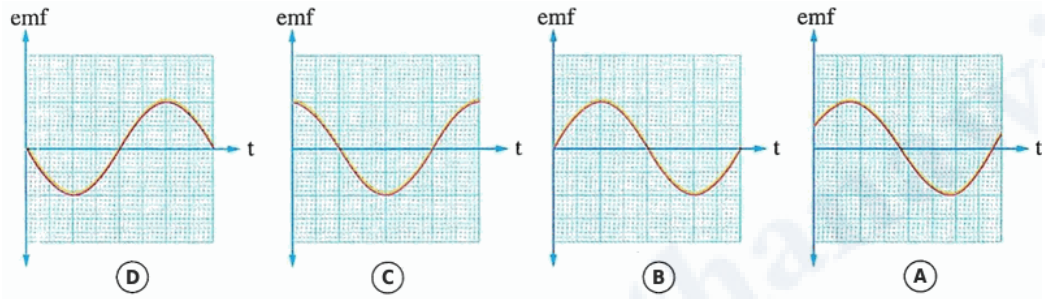
33 If the induced emf in the coil of an AC dynamo of 100 turns is given by $emf = 100\,\pi \sin(100\,\pi\,t)$, the maximum magnetic flux passing through one turn of the coil during its rotation equals .....

(A) 10^{-2} Wb (B) 2×10^{-3} Wb (C) 2×10^{-4} Wb (D) 10^{-4} Wb

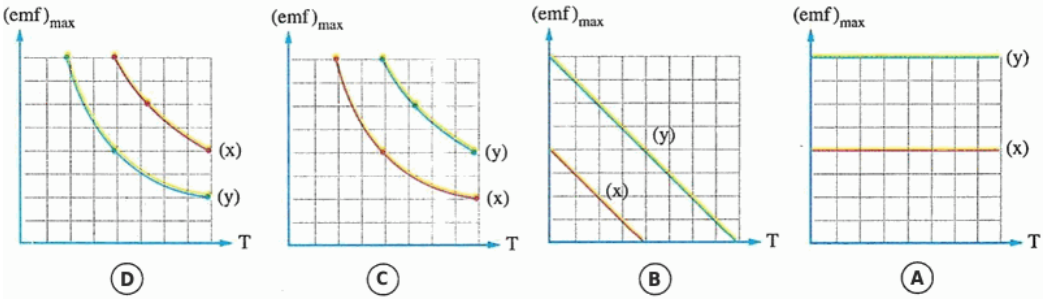
34 Which of the following graphs represents the relation between the instantaneous emf generated in the dynamo coil and the sine of the angle of rotation of the coil (sin θ), if the coil starts rotating from the zero position?



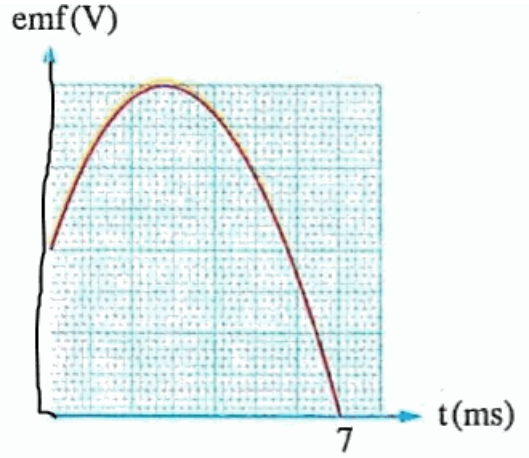
35 Which of the following graphs shows the relation between the instantaneous induced emf in the dynamo and the time (t), if the coil starts rotating from the position where its plane is inclined at 60° to the field?



36 Two dynamo coils (x) and (y) have the same area and have N and 2 N turns. They rotate in two magnetic fields of the same flux density. When the frequency of rotation of the two coils is changed, which of the following graphs represents the relation between the maximum induced emf in each coil $(emf)_{max}$ and the periodic time (T) of its rotation?



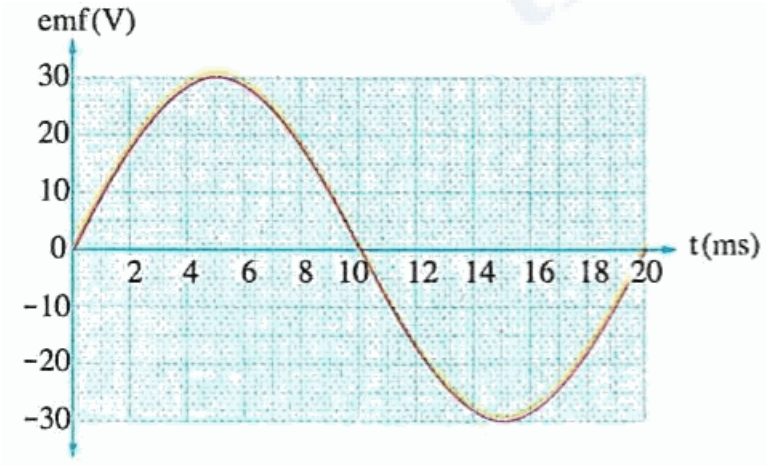
37 The opposite graph represents the relation between the induced emf in the coil of an AC dynamo and the time (t) during 7 ms. The frequency of rotation of the dynamo coil equals .....



(A) 59.5 Hz (B) 71.4 Hz (C) 119 Hz (D) 142.8 Hz

38 The opposite graph represents the relation between the induced emf in the coil of an AC dynamo during a complete revolution and the time (t). If the face area of the coil is 0.125 m^2 and it has 200 turns, then:

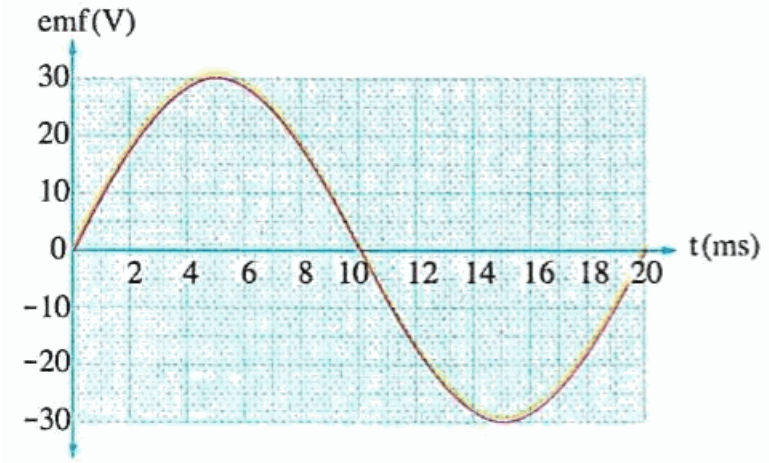
(1) The magnetic flux density in which the dynamo coil rotates equals .....



(A) 1.4×10^{-3} T (B) 2.6×10^{-3} T (C) 3.8×10^{-3} T (D) 4.2×10^{-3} T

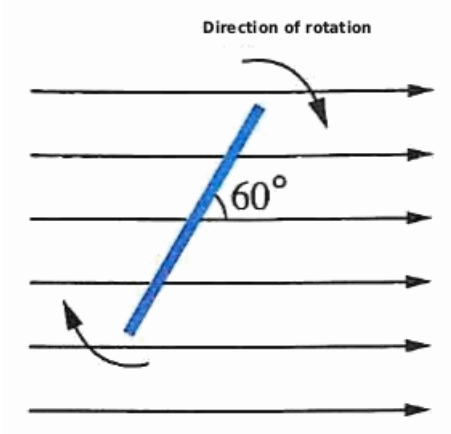
39 The opposite graph represents the relation between the induced emf in the coil of an AC dynamo during a complete revolution and the time (t). If the face area of the coil is 0.125 m^2 and it has 200 turns, then:

(2) The instantaneous emf generated when the plane of the coil makes an angle of 60° with the direction of the magnetic field equals .....



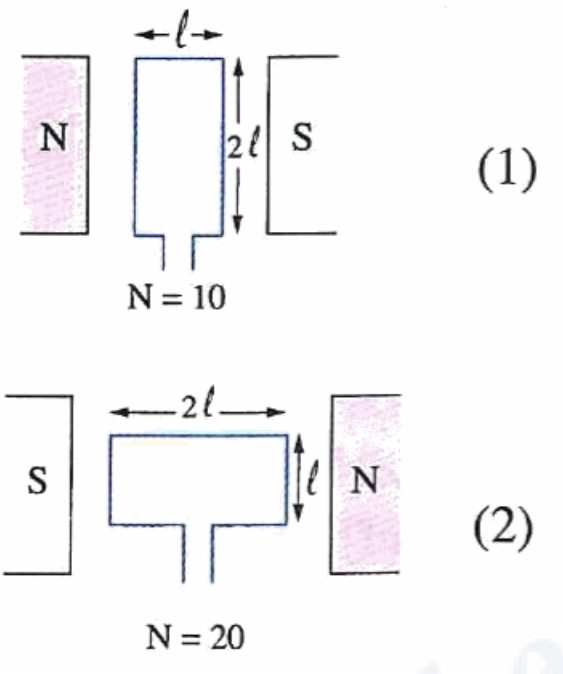
(A) 12 V (B) 14 V (C) 15 V (D) 18 V

40 The coil of an AC dynamo rotates at a frequency of 120 Hz. If at a certain moment the coil is inclined to the field at 60°, the instantaneous induced emf in the coil becomes zero after a time of ..... from that moment.



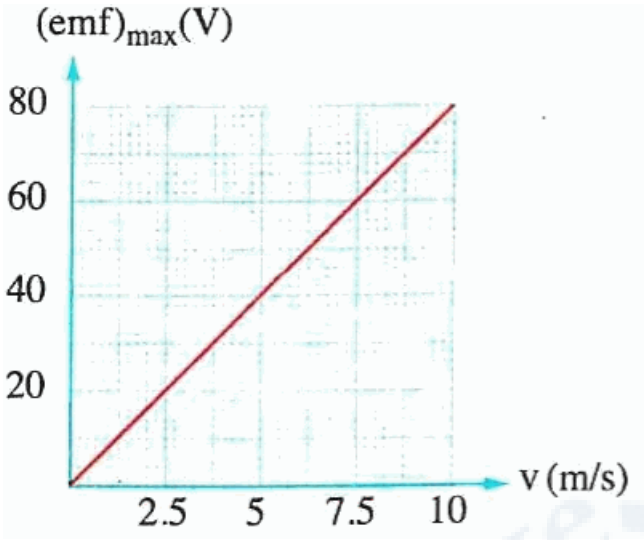
(A) 0.12 ms (B) 8.33 ms (C) 6.33 ms (D) 3.47 ms

41 The two opposite figures show two models of AC dynamo coils (1) and (2) with 10 turns and 20 turns respectively. If the flux density acting on each is B and each rotates so that the linear velocity of the side parallel to the axis of rotation is v, the ratio $(((emf)_{max\ 1})/((emf)_{max\ 2}))$ is .....



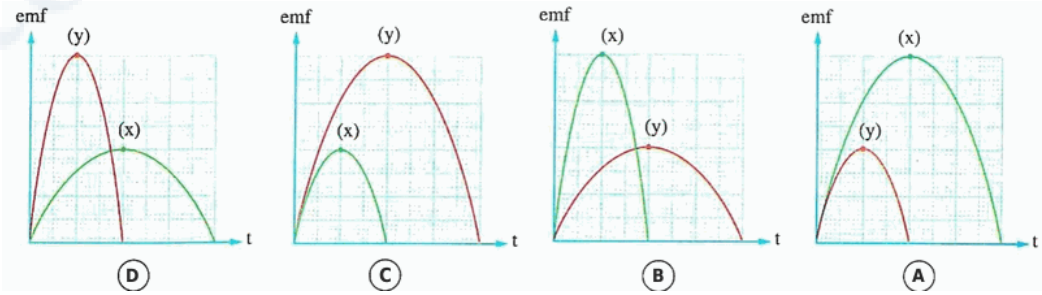
(A) 1/4 (B) 1/2 (C) 1/1 (D) 2/1

42 The coil of an AC dynamo is 10 cm long and consists of 200 turns. It rotates at a constant speed about an axis parallel to its length. The opposite graph represents the relation between the maximum induced emf in the dynamo coil $(emf)_{max}$ and the linear speed (v) of one of the long sides. The magnetic flux density acting on the coil equals .....

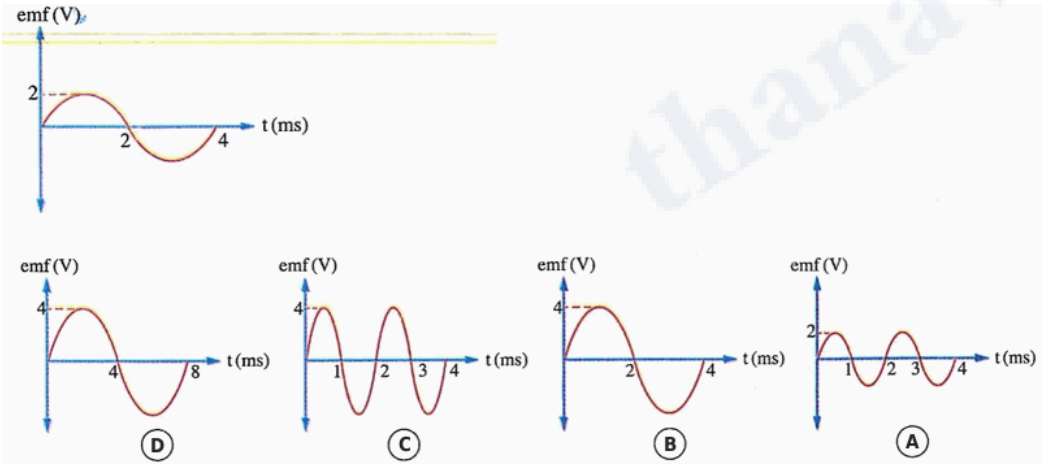


(A) 0.1 T (B) 0.2 T (C) 0.3 T (D) 0.4 T

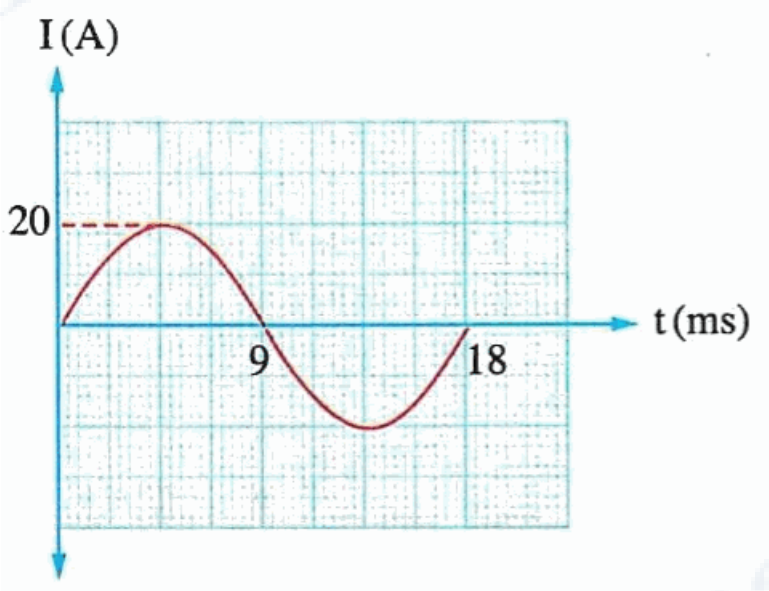
43 Two AC dynamos (x) and (y) have coils with the same number of turns, of lengths ℓ and 2 ℓ and widths w and *1/2* w respectively. Each rotates about an axis parallel to its length with the same linear speed inside two magnetic fields of the same flux density. Which of the following graphs represents the relation between the induced emf in each coil and the time (t) during half a revolution?



44 The opposite graph represents the relation between the instantaneous induced emf in a dynamo coil rotating at frequency f and the time (t). If the frequency of rotation of the coil increases to 2 f, the graph showing the same relation is .....

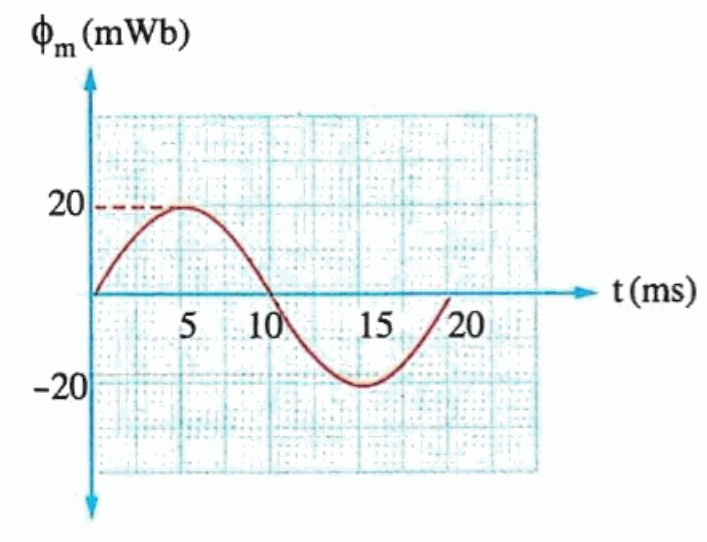


45 The opposite figure represents the relation between the induced current in the coil of an AC dynamo and the time of rotation of its coil. Given that the resistance of the dynamo circuit is 16.5 Ω, the instantaneous induced emf generated 12 ms after the zero position is approximately .....



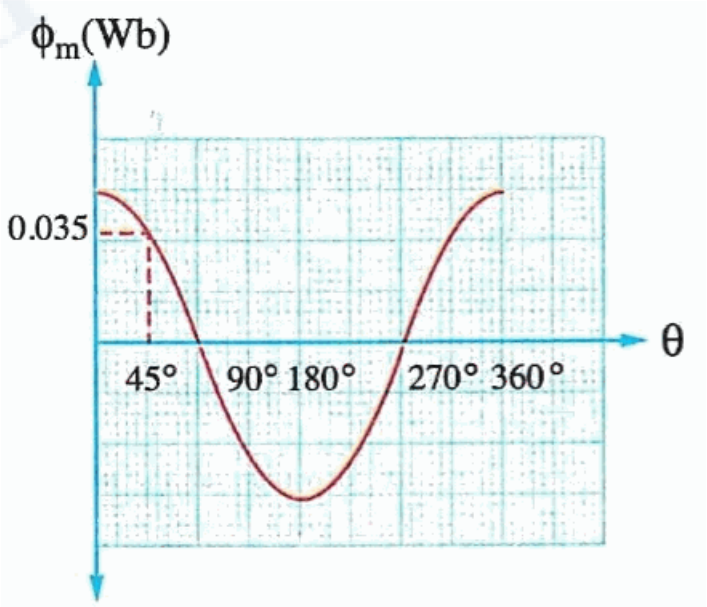
(A) 165 V (B) −176 V (C) 219 V (D) −286 V

46 The coil of an AC dynamo consists of 70 turns, and the graph represents the relation between the magnetic flux (φ_m) passing through the coil and the time (t). The induced emf in the coil at (t = 10 ms) equals .....



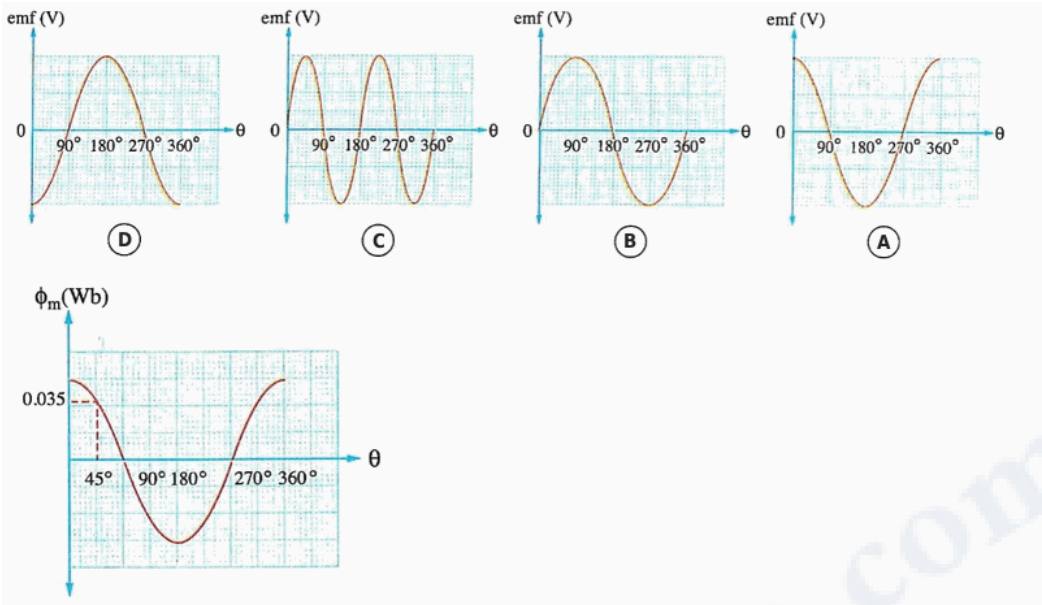
(A) 0 (B) 220 V (C) 440 V (D) 880 V

47 The opposite graph shows the change of the magnetic flux (φ_m) during a complete revolution of the coil of an electric generator that consists of 8 turns and rotates at a frequency of 50 Hz:
(1) The induced emf generated in the coil after a quarter of the periodic time equals .....

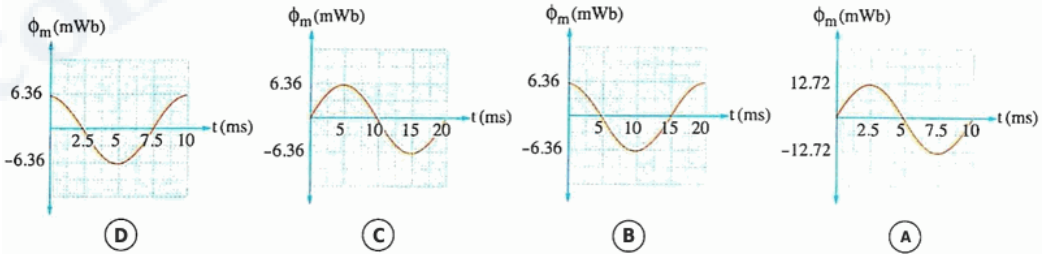


(A) 123.2 V (B) 100 V (C) 61.6 V (D) 0

48 The opposite graph shows the change of the magnetic flux (φ_m) during a complete revolution of the coil of an electric generator that consists of 8 turns and rotates at a frequency of 50 Hz:
(2) Which of the following choices represents the relation between the induced emf generated in the generator coil and the angle (θ) during a complete revolution?



49 The coil of an AC dynamo consists of 100 turns with a resistance of 5 Ω and is connected to an external resistance of 5 Ω. The current through it at any moment (t) is given by: $(I = 20 \sin(100 \pi t))$. Which of the following graphs represents the relation between the magnetic flux (φ_m) passing through the coil and the time (t)?



50 The average induced emf during a complete revolution of an AC dynamo equals .....

(A) $(emf)_{eff}$ (B) the instantaneous emf

(C) $(emf)_{max}$ (D) zero

51 When a coil rotates in a magnetic field starting from the zero position, the direction of the resulting induced emf changes every ..... revolution.

(A) *1/4* (B) *1/2* (C) *3/4* (D) 1

52 Which value of the emf generated in the dynamo coil during its rotation is NOT equal to zero?

(A) the average emf during a complete revolution

(B) the average emf during half a revolution from the position parallel to the magnetic field

(C) the instantaneous emf when the plane of the coil is parallel to the direction of the magnetic field

(D) the instantaneous emf when the plane of the coil is perpendicular to the direction of the magnetic field

53 A dynamo coil of 100 turns, each of area 200 cm^2, rotates in a magnetic flux so that one revolution takes 0.8 s, and the average induced emf during *1/4* of a revolution from the zero position is 0.4 V. The magnetic flux density equals .....

(A) 0.01 T (B) 0.04 T (C) 0.16 T (D) 0.32 T

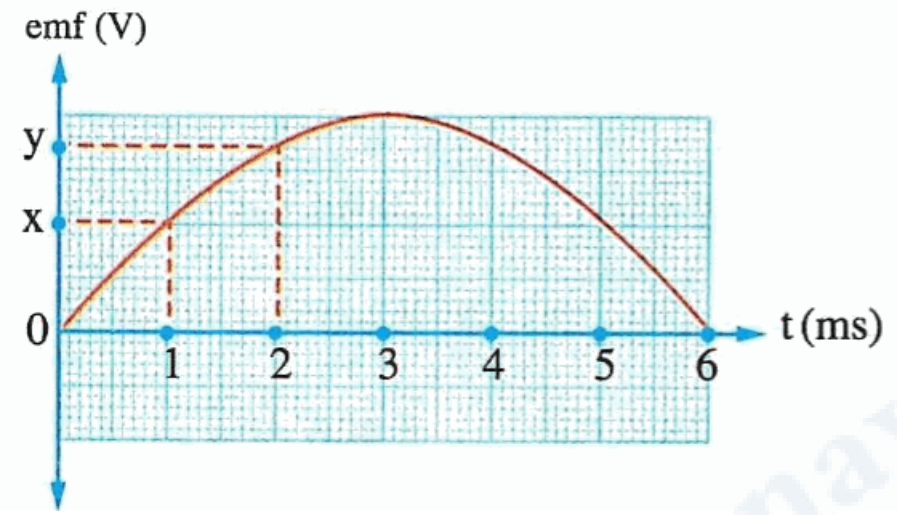
54 An AC dynamo gives a maximum emf of 100 V. The average emf during half a revolution when the coil rotates from the perpendicular position equals .....

(A) 50 V (B) 70.7 V (C) 63.6 V (D) 100 V

55 The effective emf generated by a dynamo is 50 volts. The average emf during *1/4* of a revolution from the position parallel to the field is approximately ..... volts.

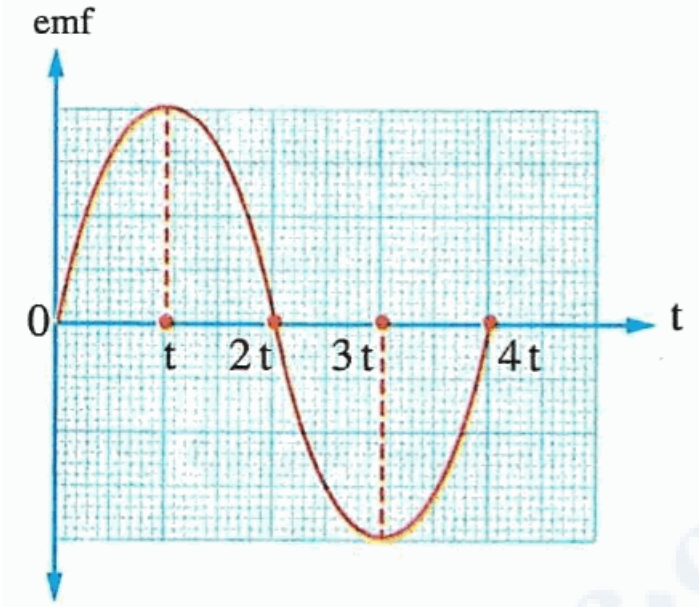
(A) 141.42 (B) 70.7 (C) 45 (D) 50

56 The opposite graph represents the change of the emf generated in the coil of an AC dynamo during half a revolution. The ratio x/y equals .....



(A) *1/2* (B) *(√(2))/2* (C) *1/3* (D) *(√(3))/3*

57 The opposite graph represents the relation between the emf generated in the dynamo coil and the time (t). In which time interval is an average emf generated in the coil equal to that generated in the interval from 0 to 2 t?



(A) the interval from t to 3 t (B) the interval from t to 2 t
(C) the interval from 0 to 3 t (D) the interval from 0 to 4 t

58 The coil of an AC dynamo consists of 100 turns, each of area 0.05 m², and rotates in a magnetic field of flux density 0.1 T, generating a maximum induced emf of 157 V, so: (given: $\pi = 3.14$)

(1) The angular velocity equals .....

(A) 157 rad/s (B) 314 rad/s (C) 471 rad/s (D) 511 rad/s

59 The coil of an AC dynamo consists of 100 turns, each of area 0.05 m², and rotates in a magnetic field of flux density 0.1 T, generating a maximum induced emf of 157 V, so: (given: $\pi = 3.14$)

(2) The frequency of the current generated in the coil equals .....

(A) 50 Hz (B) 75 Hz (C) 100 Hz (D) 120 Hz

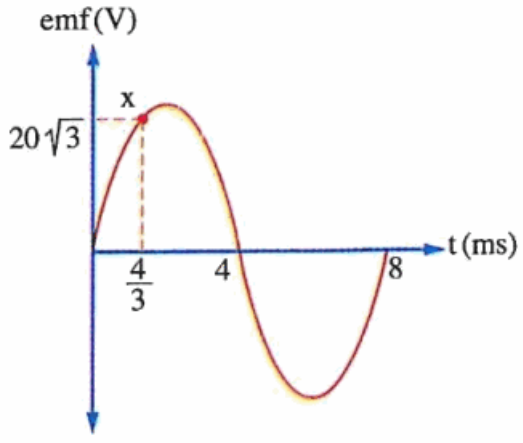
60 The coil of an AC dynamo consists of 100 turns, each of area 0.05 m², and rotates in a magnetic field of flux density 0.1 T, generating a maximum induced emf of 157 V, so: (given: $\pi = 3.14$)

(3) The average induced emf during a quarter of a revolution from the maximum position equals .....

(A) 25 V (B) 50 V (C) 75 V (D) 100 V

61 The opposite graph shows the relation between the instantaneous induced emf in a dynamo coil and the time (t), so:

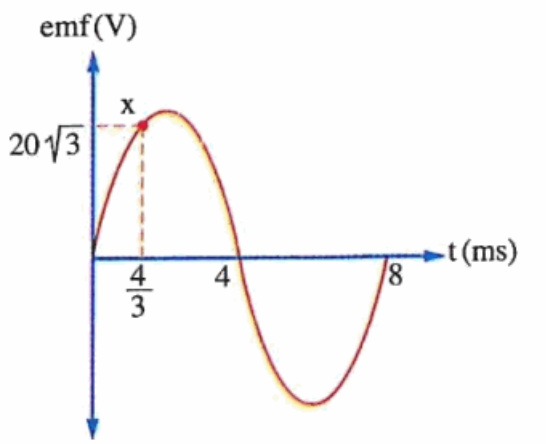
(1) The maximum induced emf in the dynamo coil equals .....



(A) 80 V (B) 62.3 V (C) 40 V (D) 34.6 V

62 The opposite graph shows the relation between the instantaneous induced emf in a dynamo coil and the time (t), so:

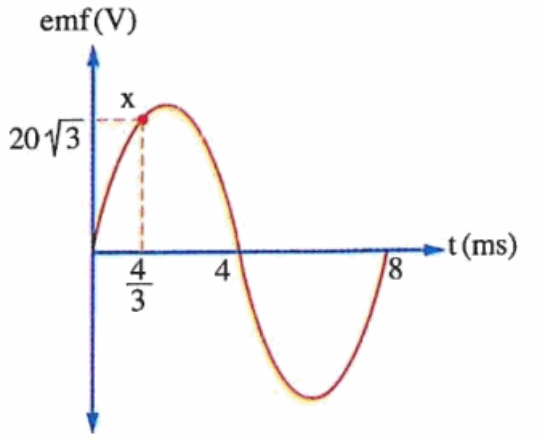
(2) The instantaneous emf of the alternating current $4/3$ ms after the moment of point x equals .....



(A) 29.96 V (B) $20\sqrt{3}$ V (C) 53.95 V (D) $40\sqrt{3}$ V

63 The opposite graph shows the relation between the instantaneous induced emf in a dynamo coil and the time (t), so:

(3) The effective value of the alternating current, if the resistance of the dynamo circuit is 10 Ω, equals .....



(A) 2.446 A (B) 2.828 A (C) 4.404 A (D) 5.656 A

64 The coil of an AC dynamo takes a time t to rotate a quarter of a revolution from the position where its plane is perpendicular to the direction of the magnetic field. The ratio between the average induced emf during that time and the instantaneous emf at the end of that time is .....

(A) $\pi/1$ (B) $\pi/2$ (C) $1/\pi$ (D) $2/\pi$

65 In an AC dynamo, when the coil rotates $1/6$ of a revolution from the position parallel to the magnetic field, the average induced emf in the coil is $(emf)_o$. When the coil rotates $1/6$ of a revolution from the position perpendicular to the field, the average induced emf in the coil is .....

(A) $((emf)_o)/3$ (B) $3\ (emf)_o$ (C) $\sqrt{(3)}\ (emf)_o$ (D) $((emf)_o)/(\sqrt{(3)})$

66 The coil of an AC dynamo rotates about an axis parallel to its length, and the induced emf generated in it is given by $emf = 240 \sin (50\ \pi\ t)$, so:

(1) The effective emf equals .....

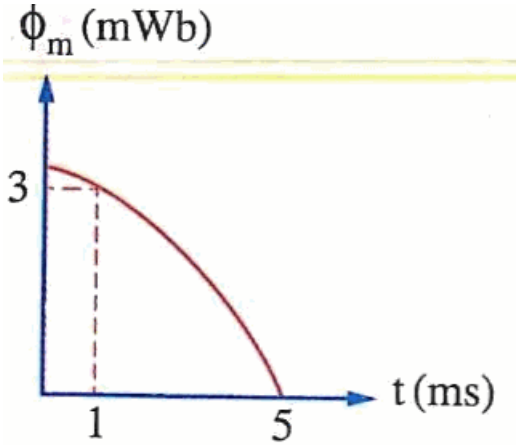
(A) $90\sqrt{(2)}$ V (B) $108\sqrt{(2)}$ V (C) $120\sqrt{(2)}$ V (D) $150\sqrt{(2)}$ V

67 The coil of an AC dynamo rotates about an axis parallel to its length, and the induced emf generated in it is given by $emf = 240 \sin (50\ \pi\ t)$, so:

(2) The periodic time of the rotation of the coil equals .....

(A) 0.02 s (B) 0.03 s (C) 0.04 s (D) 0.06 s

68 The coil of an AC dynamo consists of 600 turns with a resistance of 5 Ω and is connected to an external resistance of 5 Ω. The opposite graph represents the relation between the magnetic flux (φ_m) through the coil and the time (t) during a quarter of a revolution. The current in the dynamo coil at any moment is given by the relation .....



(A) $I = 59.4 \sin (50\ \pi\ t)$ (B) $I = 118.8 \sin (50\ \pi\ t)$

(C) $I = 59.4 \sin (100\ \pi\ t)$ (D) $I = 118.8 \sin (100\ \pi\ t)$

69 The coil of an AC dynamo is 40 cm long and 30 cm wide and has 300 turns. It rotates about an axis parallel to its length and generates a current of frequency $50/11$ hertz, and the effective induced emf is $200\sqrt{(2)}$ volts:

(1) The magnetic flux density acting on the coil equals .....

(A) $7/18$ T (B) 0.549 T (C) 0.274 T (D) $7/36$ T

70 The coil of an AC dynamo is 40 cm long and 30 cm wide and has 300 turns. It rotates about an axis parallel to its length and generates a current of frequency $50/11$ hertz, and the effective induced emf is $200\sqrt{(2)}$ volts:

(2) If the speed of rotation of the dynamo coil changes so that the linear speed of its length is 3 m/s, the maximum induced emf becomes .....

(A) 140 V (B) 197.2 V (C) 280 V (D) 395.2 V

71 The coil of an AC dynamo consists of 200 turns, each with a cross-sectional area of 2×10^{-2} m². It rotates in a magnetic field of 0.1 T and gives an emf whose effective value is 88.8 V, so: (given: $\pi = 3.14$)

(1) The maximum emf equals .....

(A) 88.8 V (B) 125.6 V (C) 177 V (D) 189.3 V

72 The coil of an AC dynamo consists of 200 turns, each with a cross-sectional area of 2×10^{-2} m². It rotates in a magnetic field of 0.1 T and gives an emf whose effective value is 88.8 V, so: (given: $\pi = 3.14$)

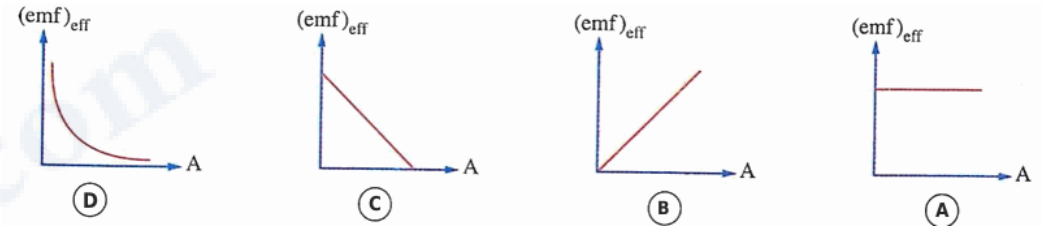
(2) The frequency of the current equals .....

(A) 50 Hz (B) 110 Hz (C) 150 Hz (D) 200 Hz

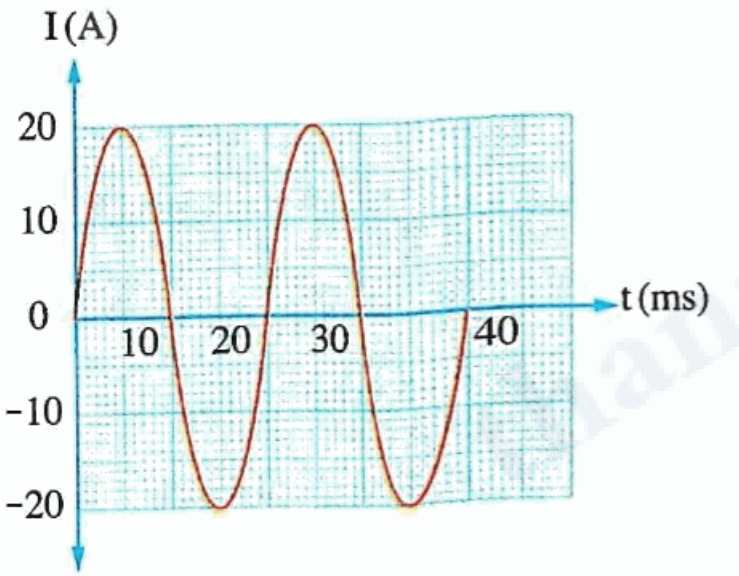
73 The effective emf generated by an AC dynamo is 100 volts. The average emf during $1/2$ a revolution from the zero position is approximately ..... volts.

(A) 141.42 (B) 70.7 (C) 90 (D) 50

74 Which of the following graphs represents the relation between the effective emf $(emf)_{eff}$ induced in the dynamo coil and the area of the coil (A)?



75 The opposite figure represents the change of the electric current generated by an AC dynamo with time, so .....



(A) angular velocity: 280.4 rad/s, effective current: 20 A

(B) angular velocity: 280.4 rad/s, effective current: $10\sqrt{(2)}$ A

(C) angular velocity: 314.29 rad/s, effective current: 20 A

(D) angular velocity: 314.29 rad/s, effective current: $10\sqrt{(2)}$ A

76 If the effective value of the current in a circuit (I_{eff}) is 2.828 A, then:

(1) The maximum current (I_{max}) equals .....

(A) 2 A (B) 4 A (C) 6 A (D) 8 A

77 If the effective value of the current in a circuit (I_{eff}) is 2.828 A, then:

(2) The instantaneous induced current when the angle (θ) between the direction of the linear velocity of the coil and the direction of the magnetic flux density is 30° equals .....

(A) 2 A (B) 4 A (C) 6 A (D) 8 A

78 An alternating current has an effective value of 3.535 A and a frequency of 50 Hz, so:

(1) The instantaneous current when the coil makes an angle of 60° with the magnetic flux equals .....

(A) 2.5 A (B) 5 A (C) 15 A (D) 25 A

79 An alternating current has an effective value of 3.535 A and a frequency of 50 Hz, so:

(2) The instantaneous current $1/200$ of a second after the zero position equals .....

(A) 5 A (B) 15 A (C) 25 A (D) 30 A

80 If the effective current in an AC circuit is 10 A, the instantaneous current:

(1) after the coil completes $1/4$ of a revolution from the zero position equals .....

(A) $10/(\sqrt{(2)})$ A (B) $10\sqrt{(2)}$ A (C) $(\sqrt{(2)})/10$ A (D) 10 A

81 If the effective current in an AC circuit is 10 A, the instantaneous current:

(2) after the coil completes $1/8$ of a revolution from the zero position equals .....

(A) $5\sqrt{(2)}$ A (B) 10 A (C) $5\sqrt{(6)}$ A (D) $10\sqrt{(2)}$ A

82 An AC source with a maximum voltage of 200 V is connected to a resistance of 50 Ω, so:

(1) The maximum current equals .....

(A) $4/(\sqrt{(2)})$ A (B) 3 A (C) 4 A (D) 5 A

83 An AC source with a maximum voltage of 200 V is connected to a resistance of 50 Ω, so:

(2) The effective current equals .....

(A) 1.727 A (B) 3.571 A (C) 2.828 A (D) 4.656 A

84 The effective value of the alternating current generated by a dynamo can be increased by each of the following EXCEPT .....

(A) increasing the speed of rotation of its coil

(B) increasing the number of turns of its coil

(C) replacing the two metal rings by a metal cylinder split into two insulated halves

(D) using a stronger magnet

85 In an AC dynamo, if the time taken by the current to change from its maximum value (I_o) to half its maximum value $(I_o/2)$ is t_o, the time needed:

(1) for the current to rise from zero to $I_o/2$ for the first time is .....

(A) $t_o/2$ (B) $t_o/3$ (C) $3/2\ t_o$ (D) $t_o/4$

86 In an AC dynamo, if the time taken by the current to change from its maximum value (I_o) to half its maximum value $(I_o/2)$ is t_o, the time needed:

(2) for the current to rise from zero to $I_o/2$ for the second time is .....

(A) $3/2\ t_o$ (B) $4/3\ t_o$ (C) $5/3\ t_o$ (D) $5/2\ t_o$

87 In an AC dynamo, if the time taken by the current to change from its maximum value (I_o) to half its maximum value $(I_o/2)$ is t_o, the time needed:

(3) for the current to rise from zero to a value equal to its effective value for the first time is .....

(A) $1/2\ t_o$ (B) $1/3\ t_o$ (C) $2/3\ t_o$ (D) $3/4\ t_o$

88 In an AC dynamo, if the time taken by the current to change from its maximum value (I_o) to half its maximum value $(I_o/2)$ is t_o, the time needed:

(4) for the current to complete one cycle is .....

(A) $4\ t_o$ (B) $6\ t_o$ (C) $8\ t_o$ (D) $12\ t_o$

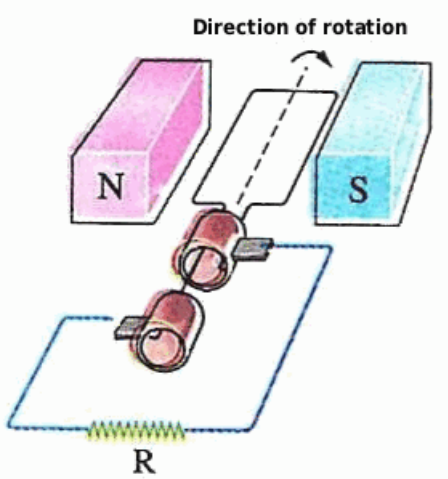
89 If the time taken by the alternating current from a dynamo to rise from zero to half its maximum value is t, the time it takes to rise from zero to the maximum value is .....

(A) t (B) 2 t (C) 3 t (D) 4 t

90 An AC dynamo has a frequency of 25 Hz, and the maximum current through its external circuit is I_o. The time for the current to rise from zero to $(\sqrt{(3)})/2\ I_o$ for the first time equals .....

(A) $1/75$ s (B) $1/120$ s (C) $1/150$ s (D) $1/300$ s

91 Starting from the position of the AC dynamo coil shown in the figure, during one and a half revolutions of the coil the current I through the resistance R changes its direction .....



(A) twice (B) three times (C) four times (D) five times

---

92 An AC generator rotates at 20 revolutions every 0.4 s and generates a current in its circuit with a maximum value of 5 A, so: (given: $\pi = 3.14$)

(1) The number of times the current reaches 5 A during 1 s, starting from the zero position, is .....

(A) 50 times (B) 75 times (C) 100 times (D) 200 times

---

93 An AC generator rotates at 20 revolutions every 0.4 s and generates a current in its circuit with a maximum value of 5 A, so: (given: $\pi = 3.14$)

(2) The number of times the current becomes zero in one second, starting from the zero position, is .....

(A) 100 times (B) 101 times (C) 102 times (D) 105 times

---

94 The coil of an AC dynamo rotates at a frequency of 100 Hz. Its rotation is followed starting from the position parallel to the direction of the magnetic field. The number of times the current reaches a value equal to its effective value during 1 s is .....

(A) 200 times (B) 201 times (C) 400 times (D) 401 times

---

95 The coil of an AC dynamo starts rotating at a uniform speed from the position parallel to the field. If the direction of the current in the dynamo coil reverses (n) times during a time of (t) seconds, the frequency of rotation of the dynamo coil equals .....

(A) n/t (B) $2n/t$ (C) $n/2t$ (D) $(n+1)/2t$

96 A dynamo coil consists of 100 turns, the resistance of each turn is 0.01 Ω, and it rotates at a frequency of 50 Hz. When its two ends are connected together, the electrical energy consumed in it during one revolution is 2 J. The maximum induced emf in the coil equals ..... (given: π = 3.14)

(A) 7.07 V (B) 14.14 V (C) 21.21 V (D) 28.28 V

---

97 An AC dynamo of negligible resistance has an instantaneous induced emf in its coil given by $emf = 200 \sin (18000\ t)$, so:

(1) The frequency of the current equals .....

(A) 200 Hz (B) 150 Hz (C) 100 Hz (D) 50 Hz

---

98 An AC dynamo of negligible resistance has an instantaneous induced emf in its coil given by $emf = 200 \sin (18000\ t)$, so:

(2) The emf 5 ms after the position where the plane of the coil is perpendicular to the magnetic field equals .....

(A) 50 V (B) 100 V (C) 150 V (D) 200 V

---

99 An AC dynamo of negligible resistance has an instantaneous induced emf in its coil given by $emf = 200 \sin (18000\ t)$, so:

(3) The electrical energy consumed in a 20 Ω resistance connected to the external circuit of the dynamo during one cycle of the current equals .....

(A) 20 J (B) 40 J (C) 60 J (D) 80 J

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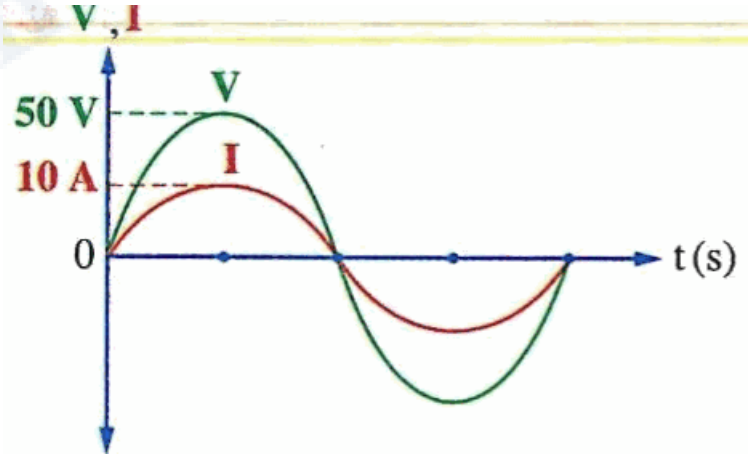
100 An AC dynamo is connected to a resistance of 8 Ω, producing 200 J of heat energy in it during 1 s. The maximum values of the current through the resistance and the p.d. across it respectively are .....

(A) 5.072 A, 45.87 V (B) 5.072 A, 56.58 V

(C) 7.072 A, 50.72 V (D) 7.072 A, 56.58 V

---

101 The opposite graph represents both the potential difference and the current in the circuit of an electric generator on the vertical axis, and the time on the horizontal axis. The electric power generated equals .....



(A) 50 W (B) 125 W (C) 250 W (D) 500 W

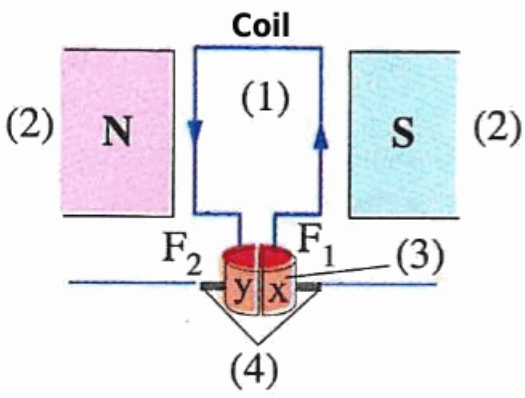
102 The ratio between the number of coils and the number of parts of the hollow metal cylinder in a DC generator equals .....

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

103 If the frequency of an AC dynamo is 50 Hz, the frequency of the current rectified into a unidirectional current produced by the dynamo equals .....

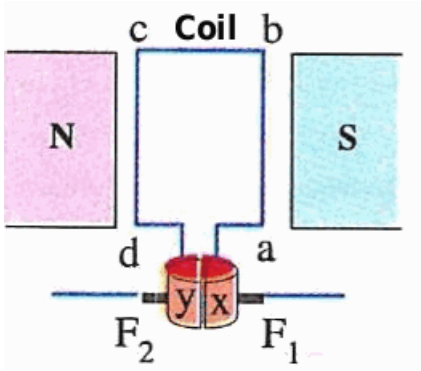
(A) 25 Hz (B) 50 Hz (C) 100 Hz (D) 200 Hz

104 The opposite figure shows the structure of a DC dynamo. The component responsible for rectifying the alternating current is .....



(A) component (1) (B) component (2) (C) component (3) (D) component (4)

105 The opposite figure shows the structure of a dynamo. If the side ab is moving out of the page at this moment and the dynamo coil rotates one complete revolution, the brush .....



(A) F_1 acts as a positive terminal in both halves of the revolution

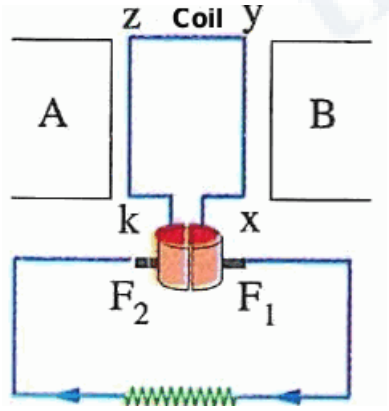
(B) F_2 acts as a positive terminal in both halves of the revolution

(C) F_1 acts as a positive terminal in only one half of the revolution

(D) F_2 acts as a positive terminal in only one half of the revolution

---

106 The opposite figure shows the structure of a DC dynamo and the direction of the current in its circuit. Which of the following choices gives the type of the magnet poles A and B and the direction of motion of the side xy of the coil?



(A) A: N, B: S, direction of motion of side xy: out of the page

(B) A: N, B: S, direction of motion of side xy: into the page

(C) A: S, B: N, direction of motion of side xy: into the page

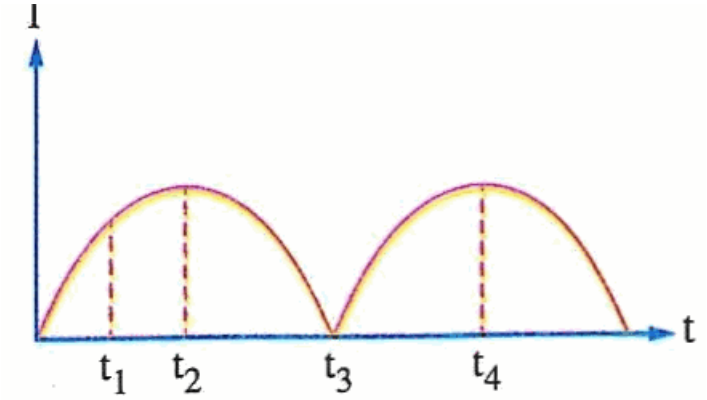
(D) A: S, B: N, direction of motion of side xy: towards pole B

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107 A single-coil DC dynamo is designed so that the angle between the plane of the insulating material in the split metal cylinder and the plane of the coil is .....

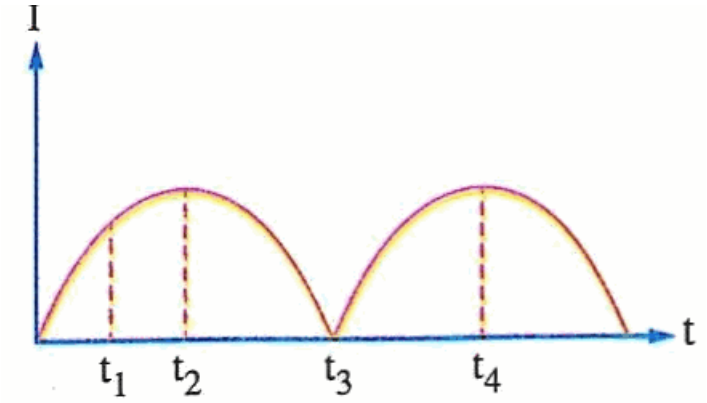
(A) 90°
(B) 60°
(C) 0°
(D) changing as the coil rotates

108 The opposite graph represents the current generated by a certain dynamo, so:
(1) The metal cylinder is divided into .....



(A) two parts
(B) three parts
(C) four parts
(D) eight parts

109 The opposite graph represents the current generated by a certain dynamo, so:
(2) The insulating material between the halves of the split cylinder touches the two graphite brushes at the moment .....

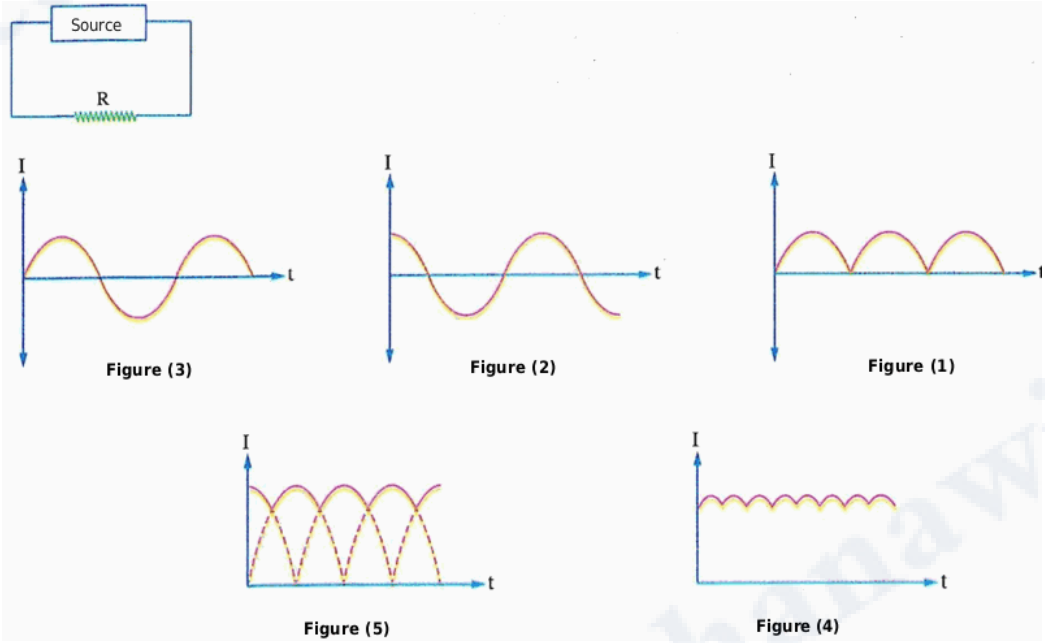


(A) t_1
(B) t_2
(C) t_3
(D) t_4

110 The following graphs represent the relation between the current through a resistance and the time in the opposite circuit.

Which of these graphs do you get if the source is:

(1) an AC dynamo whose coil started rotating from the position perpendicular to the direction of the magnetic field?

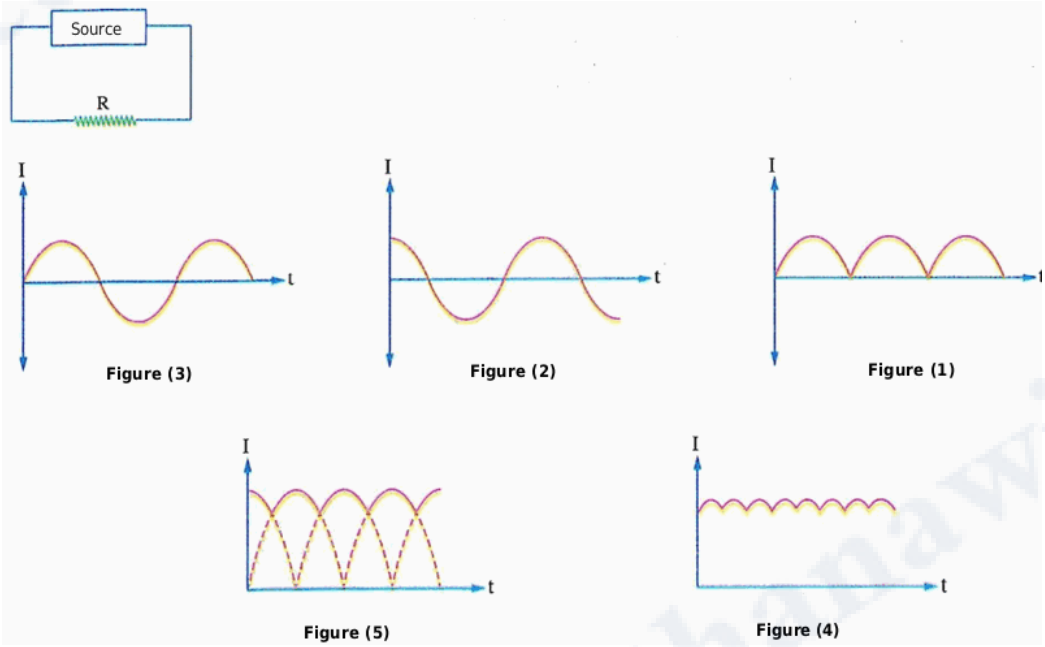


(A) figure (1) (B) figure (2) (C) figure (3) (D) figure (5)

111 The following graphs represent the relation between the current through a resistance and the time in the opposite circuit.

Which of these graphs do you get if the source is:

(2) an AC dynamo whose coil started rotating from the position parallel to the direction of the magnetic field?

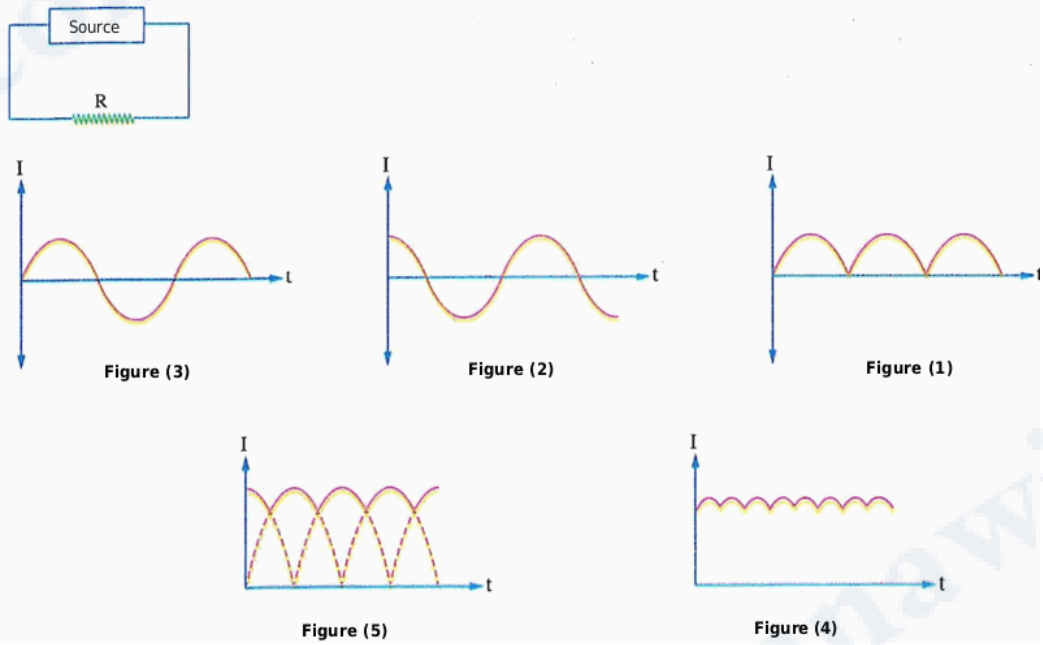


(A) figure (1) (B) figure (2) (C) figure (3) (D) figure (4)

112 The following graphs represent the relation between the current through a resistance and the time in the opposite circuit.

Which of these graphs do you get if the source is:

(3) a DC dynamo with one coil?

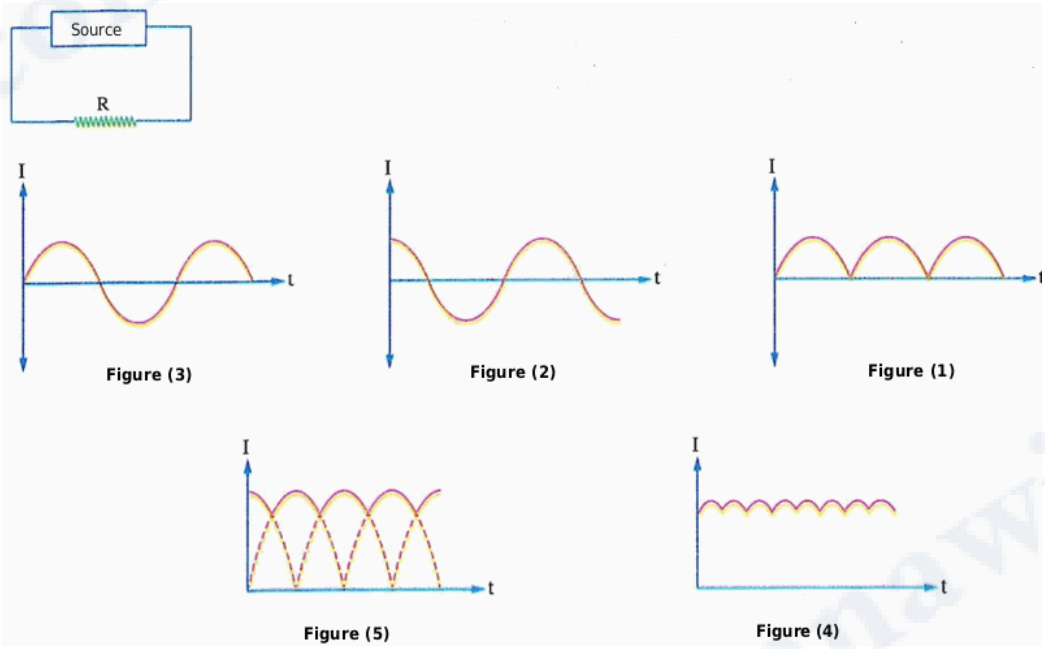


(A) figure (1) (B) figure (2) (C) figure (4) (D) figure (5)

113 The following graphs represent the relation between the current through a resistance and the time in the opposite circuit.

Which of these graphs do you get if the source is:

(4) a DC dynamo with two perpendicular coils?



(A) figure (1) (B) figure (3) (C) figure (4) (D) figure (5)

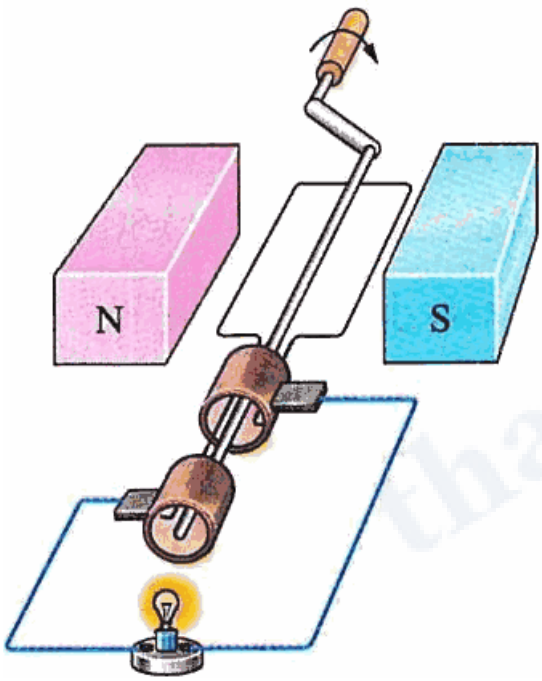
Essay questions — 19 questions

1 In the opposite figure:

(1) How do you explain that the lamp lights up when the handle is turned?

(2) State two physical quantities of the electric current in the lamp filament that increase when the handle is turned faster.

(3) What happens to the brightness of the lamp when the dynamo coil is turned in the opposite direction with the same angular velocity? Why?



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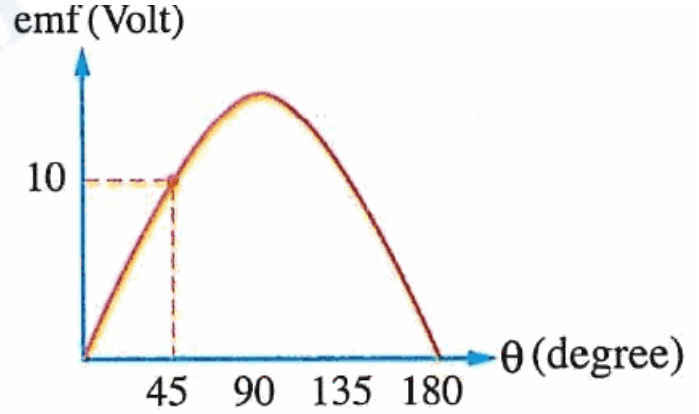
2 The coil of an AC dynamo consists of 420 turns, each of area $3 \times 10^{-3}\ m^2$, and rotates in a magnetic field of flux density 0.5 T. If the coil takes $1/200\ s$ to go from the position where its plane is perpendicular to the flux lines to the position where the maximum induced emf is generated for the first time, calculate:

(1) the maximum induced emf.

(2) the time the coil takes for the emf to rise from zero to half the maximum value.

---

3 The opposite graph shows the relation between the induced emf in the dynamo coil and the angle (θ) between the normal to the plane of the coil and the direction of the magnetic flux. Calculate the maximum induced emf.



4 The coil of an AC dynamo has 100 turns. The induced emf in it rises from zero to a value equal to its effective value for the first time after 0.01 s. If the maximum magnetic flux through the coil is 0.02 Wb, calculate:

(1) the maximum emf $(emf)_{max}$.

(2) the effective emf $(emf)_{eff}$.

5 If the instantaneous induced emf in the coil of an AC dynamo is given by: $emf = 100\pi BA \sin(100\pi t)$, calculate:

(1) the frequency of rotation of the dynamo coil.

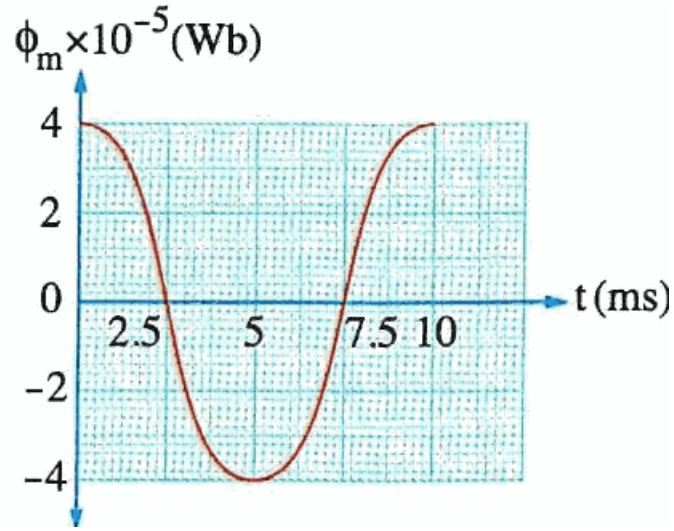
(2) the number of turns of the dynamo coil.

6 Give a reason: although the average value of the alternating current through a conductor of resistance R during a complete cycle is zero, the rate of electrical energy consumed is not zero.

7 Prove that the average induced emf in the coil of an AC dynamo while it rotates through an angle of 60° from the zero position is given by: $(emf)_{avg} = 3/(2\pi)(emf)_{max}$

8 Prove that: the average emf generated in a dynamo coil during $1/4$ of a revolution = the average emf generated during $1/2$ a revolution, starting from the zero position.

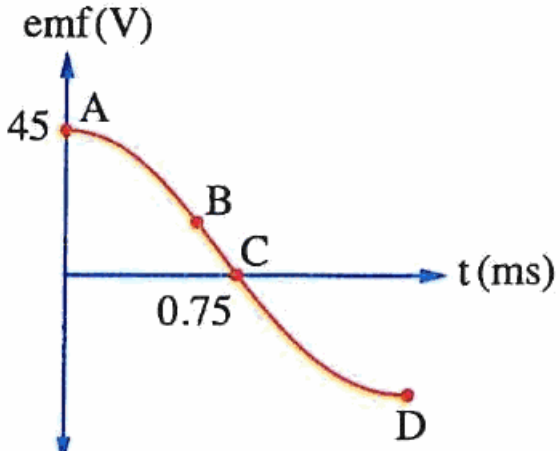
9 The opposite graph represents the relation between the magnetic flux (φ_m) through a rectangular coil of negligible resistance, consisting of 150 turns and rotating with a constant angular velocity (ω) in a magnetic field, and the time (t). The ends of the coil are connected to a 5 Ω resistance. Calculate the average induced current through the coil during the interval from 2.5 ms to 5 ms



10 The opposite graph represents the change of the induced emf in the coil of an electric generator with time:

(1) Which of the points shown in the figure represents the induced emf in the coil when it passes the position perpendicular to the magnetic field?

(2) Calculate the time the coil takes for the induced emf to change from 45 V, represented by point A, to 22.5 V for the first time.



11 The opposite figure shows the structure of an AC dynamo whose coil starts rotating from the position perpendicular to the magnetic field at a frequency of 10 Hz. Calculate the time needed for the coil to reach, from this position, each of the following cases for the first time:

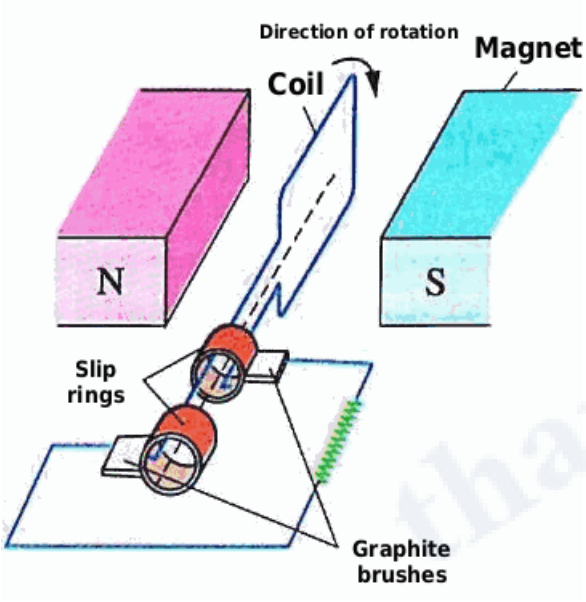
(1) The magnetic flux through the coil becomes zero.

(2) The induced emf in the coil is maximum.

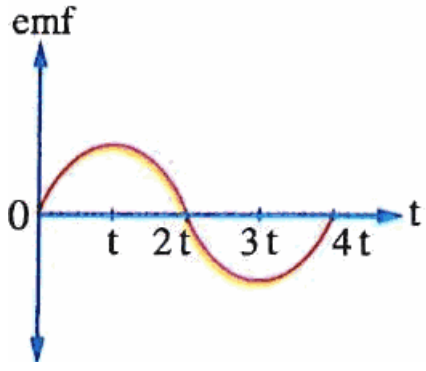
(3) The alternating current generated in the coil becomes zero.

(4) The average emf generated in the coil = zero.

(5) The instantaneous emf generated in the coil equals its effective emf.



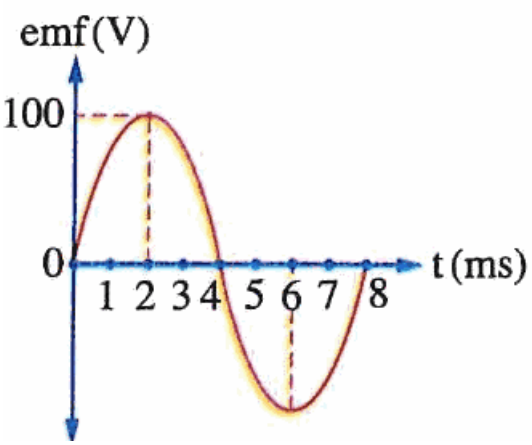
12 The opposite graph represents the (emf – t) relation for the coil of an AC dynamo. Show that the average induced emf in the coil during the interval from 0 to t is greater than the average induced emf in the coil during the interval from 0 to 3t



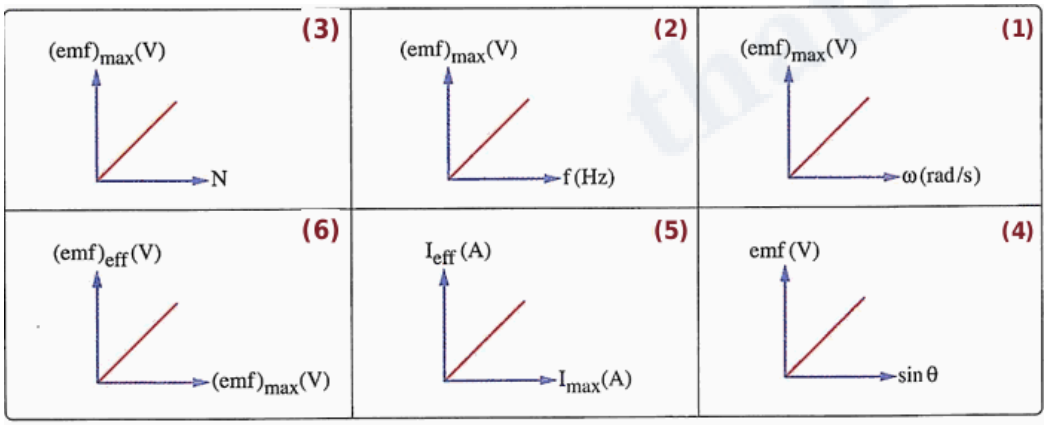
13 The opposite graph represents the characteristic curve of the induced emf in the coil of an AC dynamo. Find the average emf during each of the following time intervals:

(1) from t = 2 ms to t = 6 ms

(2) from t = 3 ms to t = 4 ms



14 Write the mathematical relation expressed by each graph, and what the slope of the straight line equals, for each of the following:



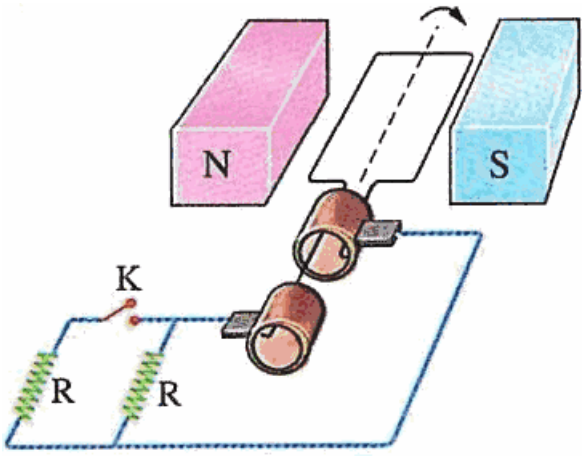
where: (emf)max = maximum induced emf, ω = angular velocity, f = frequency, N = number of turns of the coil, emf = instantaneous induced emf, θ = angle between the normal to the plane of the coil and the field, Ieff = effective current, Imax = maximum current, (emf)eff = effective emf

15 What happens, with explanation, to the maximum and effective emf generated in the coil when the number of turns of the dynamo coil is doubled and the number of revolutions of the coil per second is also doubled?

16 The opposite figure represents an AC dynamo rotating at a uniform rate. If the switch K is closed and the coil keeps rotating at the same frequency, what happens, with explanation, to:

(1) the maximum induced emf in the coil?

(2) the maximum current through the coil?



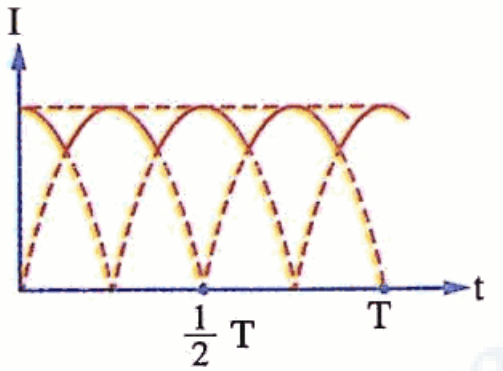
17 Explain why an electric lamp is brighter when connected to the terminals of a 12 V battery of negligible internal resistance than when connected to the terminals of a dynamo whose maximum voltage is 12 V, neglecting its internal resistance.

18 What is the type of the induced current in the dynamo coil and of the current in its external circuit when its ends are connected to a metal cylinder split into two halves insulated from each other?

19 The opposite graph represents the relation between the current (I) in the external circuit of a dynamo and the time (t):

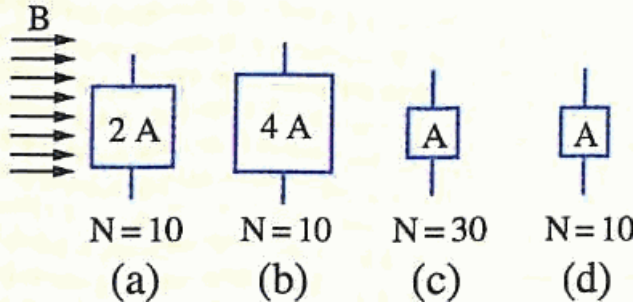
(1) How many coils does this dynamo have?

(2) How is this dynamo modified to get a current of almost constant magnitude?



Past exam questions — 36 questions

1 The figure shows four coils that differ in area and number of turns, all rotating about an axis perpendicular to a magnetic field (B) with the same angular velocity. The order of the coils in ascending order of the maximum induced emf in each coil is ..... (Trial exam / May 2021)



(A) b then c then a then d
(B) d then a then c then b
(C) c then b then a then d
(D) a then d then b then c

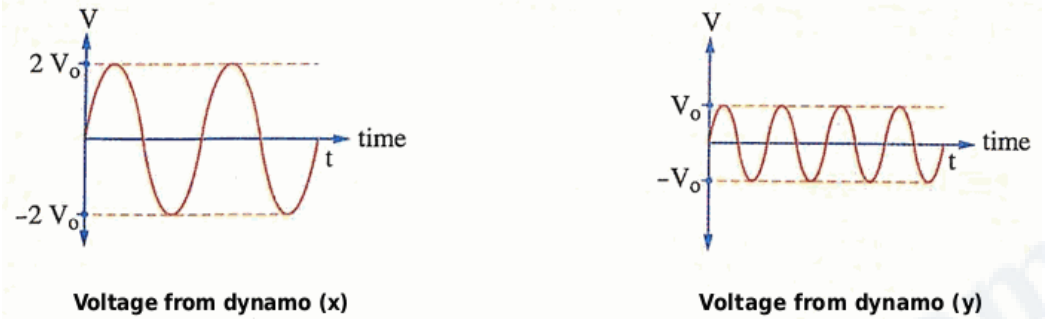
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2 An AC dynamo has a coil of 100 turns with a cross-sectional area of $250\ cm^2$. It rotates in a magnetic flux of density 200 mT starting from the position perpendicular to the flux, so that the voltage reaches its maximum value 100 times per second. The effective value of the generated voltage equals ..... (Trial exam / May 2021)

(A) 157.1 V
(B) 111.1 V
(C) 222.2 V
(D) 314.3 V

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3 Each graph represents a number of oscillations of an alternating voltage from a different dynamo (x) and (y) during the same time interval (t). Given that the coils of dynamo (x) and dynamo (y) have the same cross-sectional area and each rotates in a magnetic field of the same strength, the ratio N_y/N_x = ... (Trial exam / May 2021)



(A) *1/6*
(B) *1/8*
(C) *1/4*
(D) *1/2*

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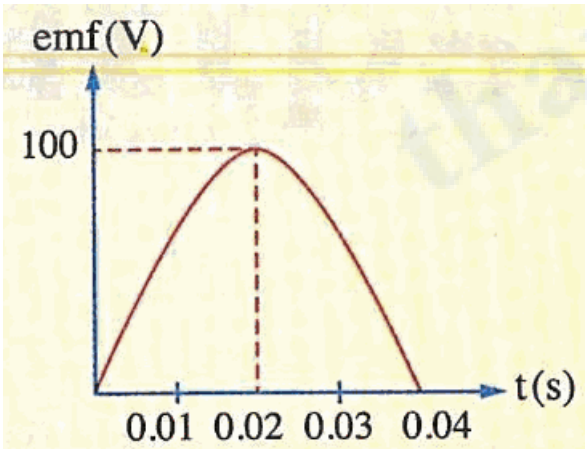
4 The coil of an AC generator consists of 12 turns, each with a cross-sectional area of $0.08\ m^2$, and the total resistance of the coil wire is 22 Ω. The coil rotates in a uniform magnetic field of flux density 0.6 T, producing a current of frequency 50 Hz. The maximum current from the dynamo when it is connected to a negligible external resistance equals ..... (Trial exam / May 2021)

(A) 8.23 A (B) 11.8 A (C) 18.5 A (D) 23.4 A

5 A simple electric generator is connected to a lamp of power 60 W and resistance 30 Ω. The maximum current through the lamp for it to work at that power equals ..... (Trial exam / June 2021)

(A) 2 A (B) √2 A (C) 1 A (D) 0.5 A

6 The opposite graph represents the relation between the induced emf in a dynamo coil and the time (t) during half a revolution. The average emf generated in the dynamo coil during the interval from t = 0 to $t = 1/75\ s$ is ..... volts. ($\pi = 3.14$) (Trial exam / June 2021)

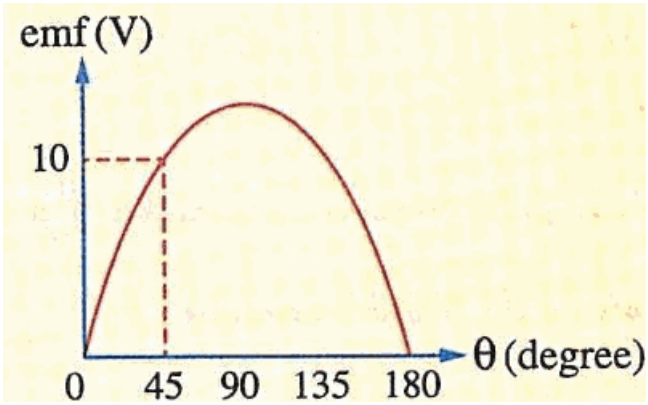


(A) 47.77 (B) 63.69 (C) 21.23 (D) 86.603

7 A simple dynamo has a coil face area of $0.02\ m^2$. It starts rotating from the position perpendicular to a magnetic field of flux density 0.1 T at 50 revolutions per second. If its coil has 100 turns, the average induced emf during half a revolution equals ..... (1st session 2021)

(A) 20 V (B) 10 V (C) 40 V (D) 30 V

8 The opposite graph represents the change of the induced emf in a dynamo with the angle (θ) between the normal to the plane of the coil and the direction of the magnetic flux. The average induced emf in the dynamo coil during $1/3$ of a revolution from the start of the rotation equals ..... (1st session 2021)

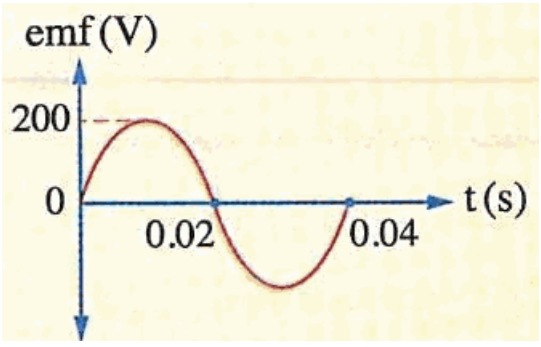


(A) 6.369 V (B) 9.006 V (C) 3.002 V (D) 10.1 V

9 In a simple electric generator, the instantaneous induced emf reaches half its maximum value for the second time $1/60$ s after it starts rotating from the position perpendicular to the magnetic field. The frequency of the produced current equals ..... (2nd session 2021, Sample exam 2025)

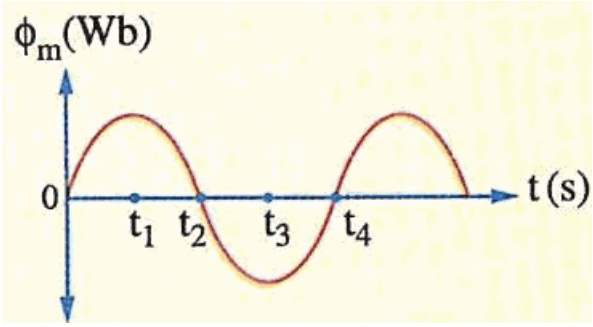
(A) 5 Hz (B) 50 Hz (C) 25 Hz (D) 15 Hz

10 The opposite graph shows the relation between the induced emf in the dynamo and the time (t). The average induced emf in the dynamo coil during the interval from t = 0 to $t = 1/30$ s equals ..... $(\pi = 3.14)$ (2nd session 2021)



(A) 127.4 V (B) 42.5 V (C) 173.2 V (D) 19.1 V

11 The opposite graph shows the change with time of the magnetic flux through a rectangular coil. The instantaneous induced emf is zero at the times ..... (2nd session 2021)

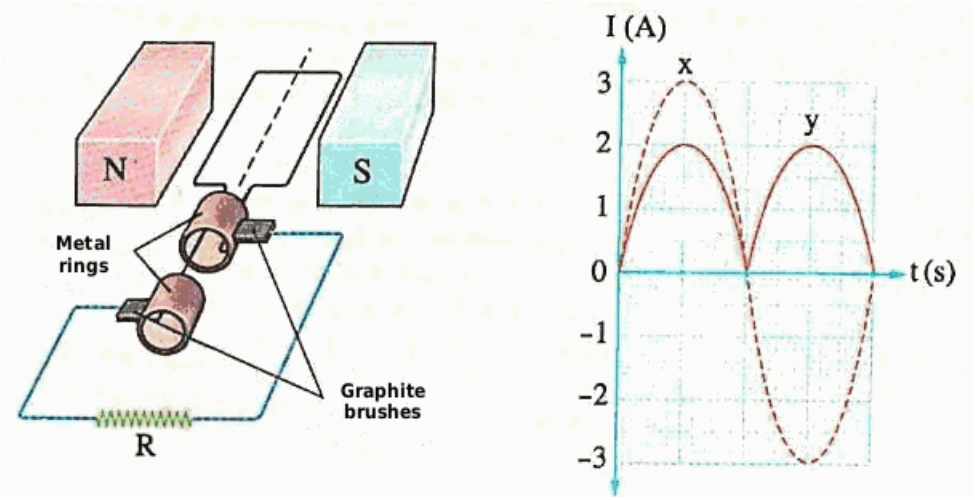


(A) t_1 , t_3 (B) t_2 , t_4 (C) t_1 , t_2 (D) t_1 , t_4

12 The coil of an AC dynamo consists of 200 turns with a cross-sectional area of $0.01\ m^2$. It rotates in a uniform magnetic field of flux density 0.3 T, producing a maximum emf of 376.99 volts. Its angular velocity = ... rad/s (π = 3.14) (1st session 2022)

(A) 100π (B) 50π (C) 150π (D) 200π

13 A student tried to represent the current generated in the dynamo coil shown in the figure by drawing two different curves x and y. Using the correct curve for the current generated in the dynamo coil, if the total resistance of the circuit is 10 Ω, the average emf during half a revolution from the zero position equals ..... (π = 3.14) (1st session 2022)



(A) 12.74 V (B) 19.11 V (C) 4.78 V (D) 3.18 V

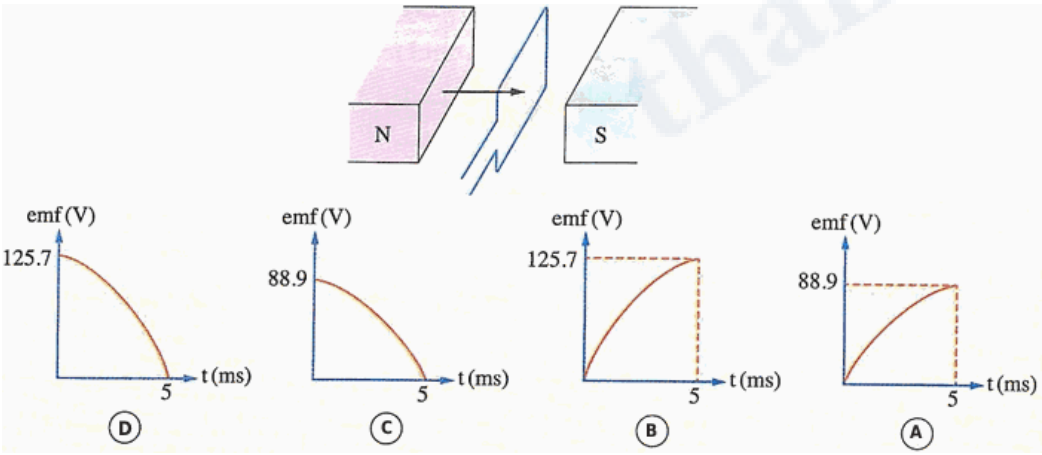
14 A coil is placed perpendicular to the direction of a uniform magnetic field. The ratio between the average induced emf in the coil when it is rotated *1/4* of a revolution in a time (t) and the average induced emf when it is rotated *1/2* a revolution in the same time (t) = ... (2nd session 2022)

(A) 0.5 (B) 1 (C) 0.25 (D) 0.75

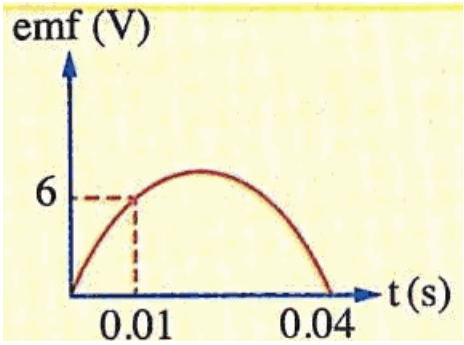
15 A dynamo coil starts rotating from the perpendicular position at a frequency of 50 Hz and gives a maximum induced emf of 100 V. The time needed for the induced emf to reach 50 V for the second time from the start of rotation equals ..... (2nd session 2022)

(A) *1/600 s* (B) *1/400 s* (C) *1/120 s* (D) *1/200 s*

16 A dynamo coil of area $0.1\ m^2$ with 200 turns rotates at a frequency of 50 Hz between the poles of a magnet of flux density 20 mT, starting from the perpendicular position as shown in the figure. Which graph correctly shows the instantaneous emf values generated in the dynamo coil as it rotates from the position shown during the interval from 0 ms to 5 ms? (2nd session 2022)



17 The opposite graph shows the relation between the induced emf in a dynamo coil and the time of rotation of the coil (t). The effective value of the induced emf equals ..... (Trial exam 2023)



(A) 6 V (B) $6\sqrt{2}$ V (C) 12 V (D) $12\sqrt{2}$ V

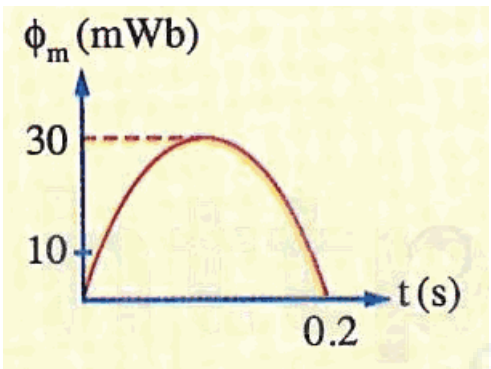
18 An AC dynamo has a coil of area $0.02\ m^2$ with 300 turns. It rotates at 1400 revolutions per minute in a magnetic field of flux density 0.01 T. The instantaneous emf generated in the coil when the plane of the coil makes an angle of 60° with the magnetic field lines equals ..... (Trial exam 2023)

(A) 8.8 V (B) 4.4 V (C) 7.62 V (D) 2.2 V

19 The coil of an AC dynamo consists of 200 turns, each of area $0.02\ m^2$. It rotates at 6000 revolutions per minute in a magnetic flux of density 0.02 T. The effective induced emf equals ..... (given: $\pi = 3.14$) (1st session 2023)

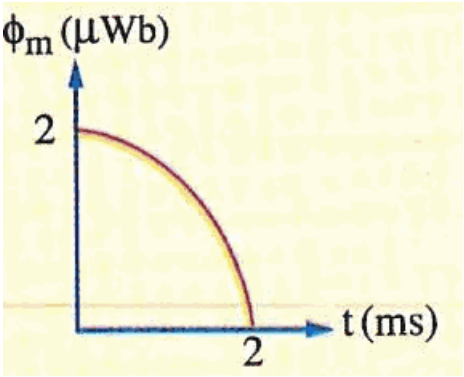
(A) 35.53 V (B) 25.12 V (C) 17.76 V (D) 12.56 V

20 The opposite graph represents the change with time (t) of the magnetic flux (φ_m) cutting a coil. Given that the coil has 200 turns, the average induced emf in the coil during the time interval shown in the figure is ..... (1st session 2023)



(A) 0 V (B) 60 V (C) 30 V (D) 45 V

21 The opposite graph shows the change with time (t) of the magnetic flux (φ_m) through a dynamo coil of 200 turns. The instantaneous emf generated in the coil 0.1 ms after the zero position of the coil equals ..... (given: $\pi = 3.14$) (1st session 2023)

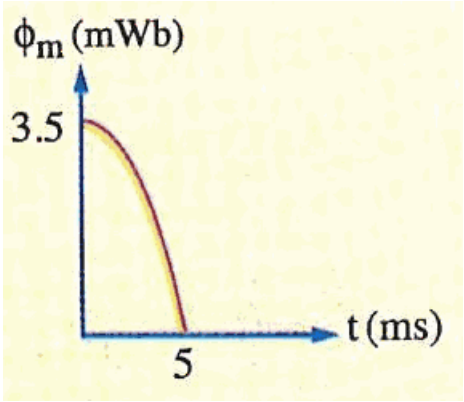


(A) 0.0025 V (B) 0.25 V (C) 0.025 V (D) 0.00025 V

22 An AC dynamo gives a current of frequency 50 Hz. The time for the current to rise from zero to a value equal to its effective value for the first time equals ..... (2nd session 2023)

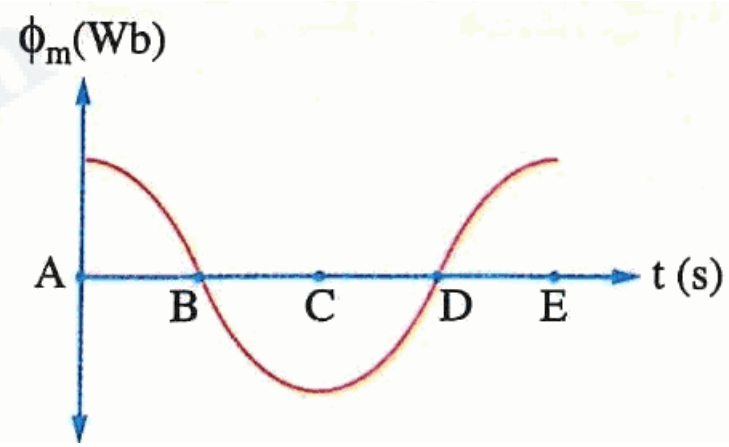
(A) 0.5 ms (B) 1.5 ms (C) 2.5 ms (D) 0.25 ms

23 The graph represents the change with time (t) of the magnetic flux (φ_m) through a dynamo coil of 200 turns. The average emf generated during the quarter revolution shown = ... (2nd session 2023)



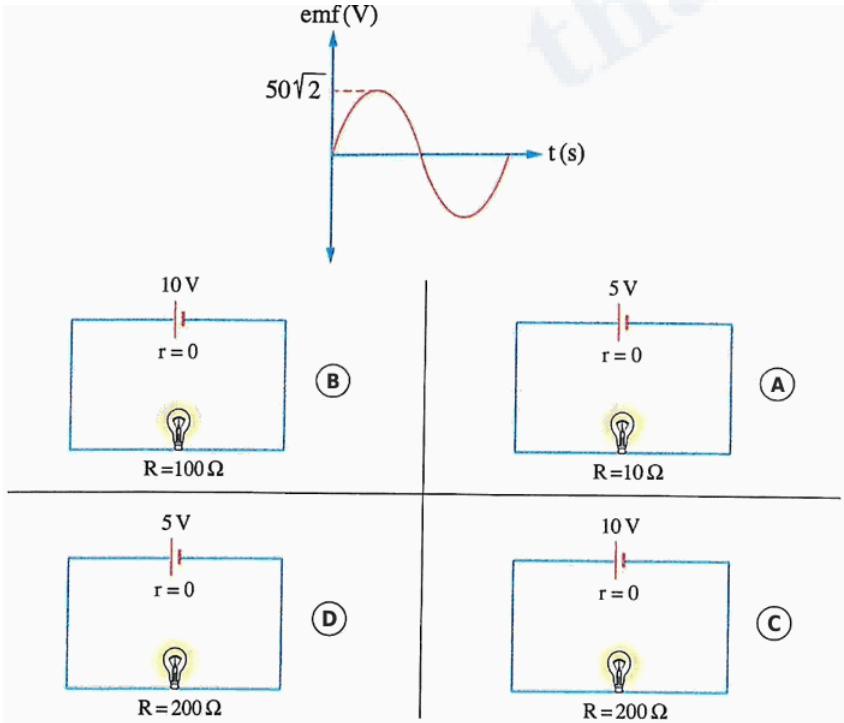
(A) 155.56 V (B) 220 V (C) 140 V (D) 110 V

24 The graph shows the change with time (t) of the magnetic flux (φ_m) through a dynamo coil during its rotation. The instantaneous emf generated in the coil is ..... (1st session 2024)

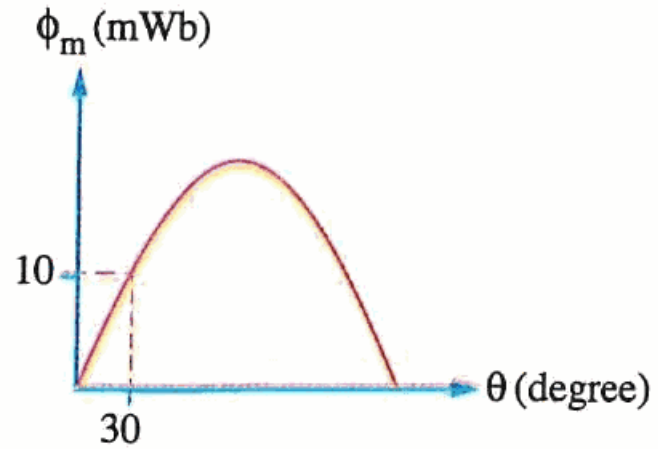


(A) zero at the two moments B , D
(B) maximum at the two moments D , C
(C) zero at the two moments A , C
(D) maximum at the two moments B , C

25 The opposite graph represents the relation between the induced emf in an AC generator whose circuit resistance is 500 Ω and the time (t). The effective current in the generator circuit was (I). Which of the following circuits carries a current (I)? (1st session 2024)



26 The opposite graph shows the relation between the magnetic flux (φ_m) through a dynamo coil and the angle of rotation (θ) from the position parallel to the magnetic flux lines. Given that the dynamo coil has 50 turns and rotates at a frequency of 50 Hz, the maximum induced emf in the dynamo coil equals ..... $(\pi = 3.14)$ (2nd session 2024)



(A) 222.2 V (B) 314 V (C) 307.8 V (D) 200 V

27 The current in the coil of a DC dynamo ..... (Sample exam 2025)

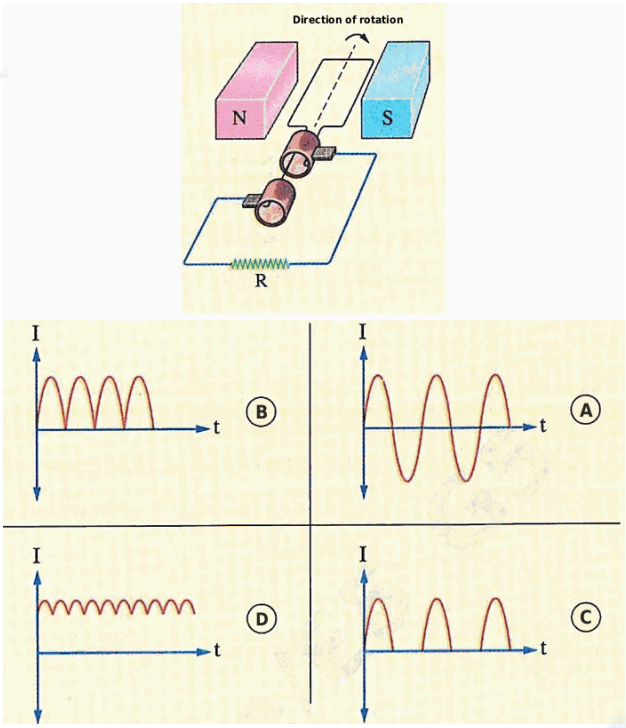
(A) changes its direction every revolution

(B) changes its direction every half revolution

(C) changes its direction every quarter revolution

(D) is always in the same direction

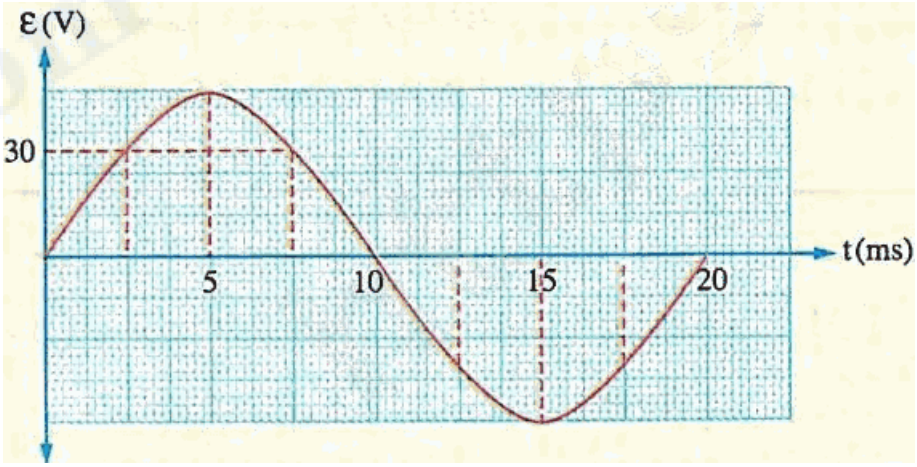
28 The current generated by the device shown in the opposite figure and flowing in the resistance (R) is represented by the graph ..... (Sample exam 2025)



29 The instantaneous induced emf of an AC dynamo is given by V = 200 sin (18000 t). If its coil starts rotating from the perpendicular position, the time taken to reach (– 100 V) for the first time is ..... (Sample exam 2025)

(A) *1/600 s* (B) *5/600 s* (C) *1/100 s* (D) *7/600 s*

30 The graph shows the change of the induced emf (ε) with time (t) in the coil of an AC dynamo of negligible ohmic resistance when the coil rotates with a uniform angular velocity (ω). If the angular velocity of the dynamo coil is increased to (2ω), then ..... (1st session 2025)



(A) periodic time 40 ms , effective voltage 60 V

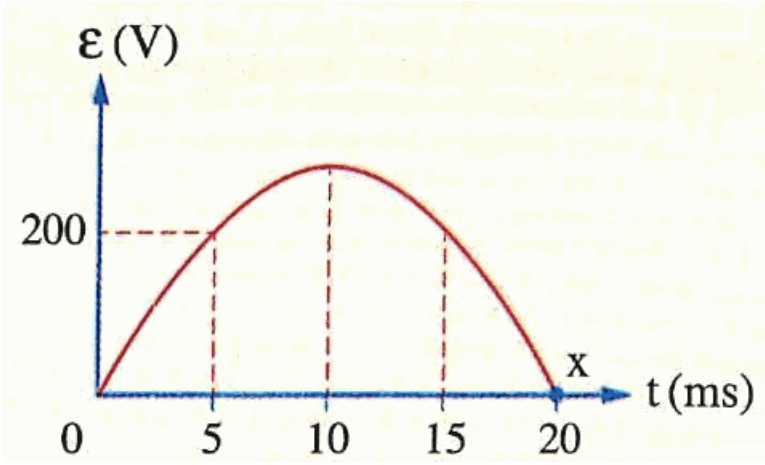
(B) periodic time 40 ms , effective voltage 15 V

(C) periodic time 10 ms , effective voltage 60 V

(D) periodic time 10 ms , effective voltage 15 V

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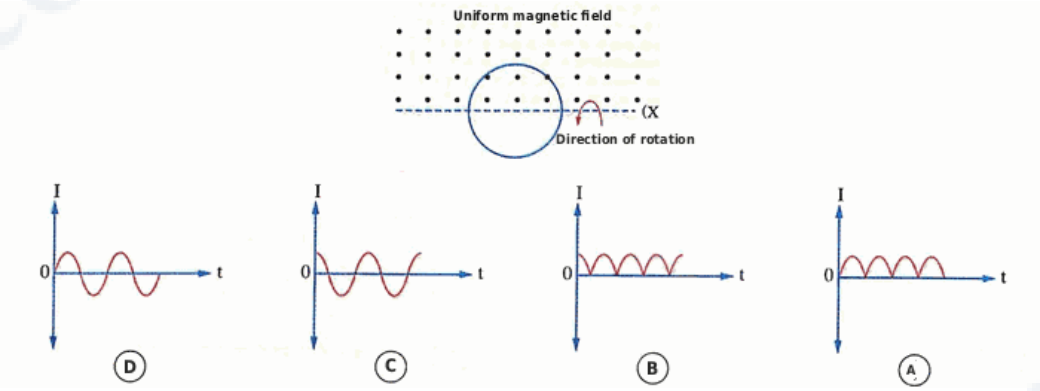
31 An AC dynamo has a coil of 100 turns, and the graph represents the relation between the induced emf in the dynamo coil (ε) and the time (t) during half a revolution. What is the magnetic flux through the cross-section of the coil when it reaches the moment (x)? (take: $\pi = 3.14$) (2nd session 2025)



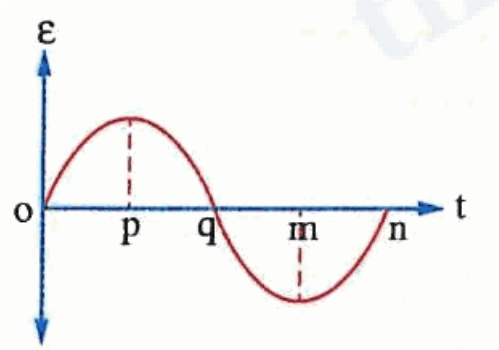
(A) 0 Wb (B) 2.5×10^{-2} Wb (C) 9×10^{-3} Wb (D) 1.8×10^{-2} Wb

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32 The opposite figure shows a circular coil of one turn in the plane of the page, with half of the coil inside a uniform magnetic field directed out of the page. When the coil rotates at a constant speed from the perpendicular position about the axis (X), which of the following graphs correctly represents the change of the induced current (I) in the coil with time (t)? (Sample exam 2026)



33 The opposite graph shows the change of the instantaneous induced emf (ε) in the coil of an AC dynamo during a complete revolution. In which time interval is the average induced emf during the rotation of the dynamo coil equal to its value during the interval (op)? (Sample exam 2026)



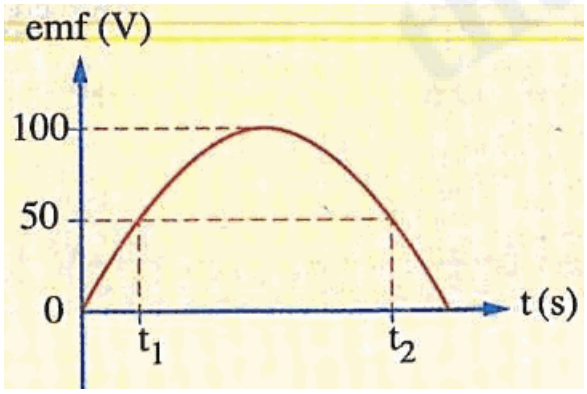
(A) during the interval (pm)
(B) during the interval (om)
(C) during the interval (on)
(D) during the interval (qn)

34 The opposite graph shows the relation between the instantaneous induced emf in the coil of an AC dynamo and the time (t) during one revolution. The ratio between the average emf during the interval from 2t to 7t and the average emf during the interval from 5t to 10t equals ..... (Sample exam 2026)



(A) *2/5* (B) *2/3* (C) *1/1* (D) *1/5*

35 The opposite graph shows the relation between the instantaneous induced emf in the coil of an AC dynamo and the time (t). The average induced emf in the coil during the interval from (t_1) to (t_2) equals ..... (Sample exam 2026)



(A) 82.7 V (B) 87 V (C) 90 V (D) 95.5 V

36 In an experiment to make a simple electric generator, a wire of length (ℓ) was wound into a square coil of one turn, and the coil was rotated with an angular velocity (ω) between the poles of a magnet; the maximum induced emf in the coil was (V). If the coil is replaced by another made by winding a wire of length (2ℓ) into a square coil of one turn too, and it is rotated with the same angular velocity (ω) between the poles of the same magnet, calculate the maximum induced emf in the coil in terms of (V). (Sample exam 2026)

Answer key and solutions

Multiple choice questions

1 C	2 B	3 C	4 B	5 B	6 C	7 B	8 B	9 B	10 D
11 B	12 A	13 A	14 D	15 D	16 C	17 D	18 B	19 D	20 B
21 B	22 A	23 A	24 B	25 A	26 C	27 B	28 D	29 D	30 B
31 B	32 C	33 A	34 B	35 A	36 C	37 A	38 C	39 C	40 D
41 C	42 B	43 D	44 C	45 D	46 C	47 A	48 B	49 B	50 D
51 B	52 C	53 B	54 C	55 C	56 D	57 B	58 B	59 A	60 D
61 C	62 B	63 B	64 D	65 D	66 C	67 C	68 C	69 A	70 C
71 B	72 A	73 C	74 B	75 D	76 B	77 A	78 A	79 A	80 B
81 B	82 C	83 C	84 C	85 A	86 D	87 D	88 B	89 C	90 C
91 B	92 C	93 B	94 C	95 C	96 B	97 D	98 D	99 A	100 D
101 C	102 A	103 C	104 C	105 B	106 B	107 A	108 A	109 C	110 C
111 B	112 A	113 D							

1 **Answer (C)**

The direction of the induced current in the dynamo coil is found by Fleming's right-hand rule.

2 **Answer (B)**

The rate at which the coil cuts the flux lines is maximum when its plane is parallel to them ($\theta = 90^\circ$)

3 **Answer (C)**

When the plane of the coil is perpendicular to the field, the coil does not cut the flux lines $(\theta = 0)$, so the rate of cutting is zero.

4 **Answer (B)**

In the parallel position no flux passes through the coil, so $\varphi_m = 0$, and its rate of change is maximum, so the emf is maximum.

5 **Answer (B)**

$emf = NBA\omega sin\theta$ is maximum when $sin\theta = 1$, that is when the plane of the coil is parallel to the field.

6 **Answer (C)**

The coil starts from the position parallel to the field, so the emf starts from its maximum value and then decreases: $emf = emf_{max} cos\omega\, t$

7 **Answer (B)**

$T = (2\pi)/(\omega)$

8 **Answer (B)**

$f = (\omega)/(2\pi) = 377.2/(2 \times 3.14) = 60$ Hz

9 **Answer (B)**

$emf_{max} = NBA\omega$, so it becomes $2 \times 1/4 = 1/2$, that is it decreases to half.

10 **Answer (D)**

$emf_{max} \propto \omega \Rightarrow \omega_2 = 281 \times 480/120 = 1124$ rad/s

11 **Answer (B)**

$emf_{max} \propto f \Rightarrow 150/100 = (f + 25)/f \Rightarrow f = 50$ Hz

12 **Answer (A)**

$emf_{max} = NBA\omega$ does not depend on the angle of rotation, so the relation is a constant horizontal line.

13 **Answer (A)**

$emf_{max} = NBA\omega$ does not depend on the resistance of the coil, so the relation is a constant horizontal line.

14 **Answer (D)**

From the graph, $emf_{max} = 150$ V at $N = 30$

$A = (emf_{max})/(NB\omega) = 150/(30 \times 0.4 \times 100) = 0.125\ m^2$

15 **Answer (D)**

$emf_{max} = NBA\omega$ with N and B constant, so $A = (emf_{max})/(NB\omega)$

Coil k has the greatest emf and the slowest rotation (the longest half-revolution time), so the greatest area; coil x is the opposite.

16 **Answer (C)**

$B = (emf_{max})/(NA\omega) = 628/(400 \times 0.5 \times 10\pi) = 0.1$ T

The direction of the current is found by Fleming's right-hand rule.

17 **Answer (D)**

In the relation $emf = NBA\omega sin\theta$, the angle θ is between the field and the normal to the plane of the coil, not between the field and the plane of the coil.

18 **Answer (B)**

θ between the field and the normal to the coil $= 90^\circ - 60^\circ = 30^\circ$

$emf = emf_{max} sin30^\circ = 1/2\ emf_{max}$

19 **Answer (D)**

θ between the field and the normal to the coil $= 90^\circ - 45^\circ = 45^\circ$

$emf = emf_{max} sin45^\circ = (emf_{max})/(sqrt2) = emf_{rms}$, that is its effective value.

20 **Answer (B)**

In the perpendicular position $emf = 0$, then $\theta = frac360^\circ 12 = 30^\circ$

$emf = 200sin30^\circ = 100$ V

21 **Answer (B)**

$emf = emf_{max} sin\theta = 200sin30^\circ = 100$ V

22 **Answer (A)**

$\theta = 90^\circ - 60^\circ = 30^\circ$

$emf = 200sin30^\circ = 100$ V

23 **Answer (A)**

When the plane of the coil is perpendicular to the field, the coil does not cut the flux lines $(\theta = 0)$, so $emf = 0$

24 **Answer (B)**

$\omega = 2\pi f = 2 \times 22/7 \times 30 = 188.57$ rad/s

$emf_{max} = NBA\omega = 200 \times 0.1 \times 0.06 \times 188.57 = 226.29$ V

25 **Answer (A)**

$\theta = 90^\circ - 60^\circ = 30^\circ$

$emf = emf_{max} \sin 30^\circ = 226.29 \times 0.5 = 113.15$ V

26 **Answer (C)**

$T = 1/30$ s, so a quarter of a revolution is $\Delta t = 1/120$ s and $\Delta\varphi_m = BA$

$emf_{avg} = N\,BA/(\Delta t) = 200 \times 0.1 \times 0.06 \times 120 = 144$ V

27 **Answer (B)**

Half a revolution: $\Delta t = 1/60$ s and $\Delta\varphi_m = 2BA$

$emf_{avg} = 200 \times (2 \times 0.1 \times 0.06)/(1/60) = 144$ V

28 **Answer (D)**

In a complete revolution the flux returns to its initial value, $\Delta\varphi_m = 0$, so $emf_{avg} = 0$

29 **Answer (D)**

$\omega = 2\pi f = 2 \times 22/7 \times 1000/60 = 104.76$ rad/s

After a quarter of a revolution from the perpendicular position, its plane is parallel to the field, so

$emf = emf_{max} = NBA\omega = 420 \times 0.4 \times 0.005 \times 104.76 = 88$ V

30 **Answer (B)**

$emf = emf_{max} \sin 150^\circ = 88 \times 0.5 = 44$ V

31 **Answer (B)**

$\omega = 2\pi f = 2\pi \times 60 = 120\pi$ rad/s and $\theta = \omega t = (120\pi)/720 = (\pi)/6 = 30^\circ$

$emf = NBA\omega \sin\theta = 70 \times 0.5 \times 4 \times 10^{-2} \times 120 \times 3.14 \times \sin 30^\circ \approx 264$ V

32 **Answer (C)**

$\omega = 100\pi$ and $emf_{max} = NBA\omega = 12.5$

$B = 12.5/(600 \times 25 \times 10^{-4} \times 100\pi) \approx 2.7 \times 10^{-2}$ T

33 **Answer (A)**

$emf_{max} = N\,\varphi_{max}\,\omega \Rightarrow \varphi_{max} = (100\pi)/(100\times 100\pi) = 10^{-2}$ Wb

34 **Answer (B)**

$emf = NBA\omega sin\theta$, so the relation with $sin\theta$ is a straight line through the origin.

35 **Answer (A)**

The plane of the coil is inclined at 60° to the field, so the angle with the normal is 30°; the emf starts from $0.5\ emf_{max}$, positive, and increases to the maximum value.

36 **Answer (C)**

$emf_{max} = NBA\omega = (2\pi\ NBA)/T$, so it is inversely proportional to T (a hyperbola-like curve)
Coil y has $2N$, so its curve is above the curve of x

37 **Answer (A)**

The curve starts at $\theta = 30^\circ$ and ends at 180°, that is 150° in 7 ms
$T = 7\times 360/150 = 16.8$ ms and $f = 1/T \approx 59.5$ Hz

38 **Answer (C)**

From the graph $emf_{max} = 30$ V and $T = 20$ ms, so $\omega = (2\pi)/0.02 = 314$ rad/s
$B = (emf_{max})/(NA\omega) = 30/(200\times 0.125\times 314) \approx 3.8\times 10^{-3}$ T

39 **Answer (C)**

$\theta = 90^\circ - 60^\circ = 30^\circ$
$emf = 30sin30^\circ = 15$ V

40 **Answer (D)**

The coil becomes perpendicular to the field after rotating $60^\circ + 90^\circ = 150^\circ$
$t = 150/360\ T = 150/(360\times 120) = 3.47$ ms

41 **Answer (C)**

$emf_{max} = 2NBLv$, where L is the length of the side parallel to the axis (the width has no effect)
$((emf)_1)/((emf)_2) = (10\times 2\ell)/(20\times \ell) = 1/1$

42 **Answer (B)**

$emf_{max} = 2NBLv$, so the slope of the line $= 2NBL = 80/10 = 8$
$B = 8/(2\times 200\times 0.1) = 0.2$ T

43 **Answer (D)**

$emf_{max} = 2NBLv$, and coil y has a length 2ℓ, so its emf_{max} is twice that of x
Its radius $w/2$ is half, so $T = (2\pi r)/v$ is half, that is y is higher and narrower.

44 **Answer (C)**

$emf_{max} = NBA\omega$, so doubling the frequency doubles emf_{max} to 4 V
and the periodic time is halved from 4 ms to 2 ms.

45 **Answer (D)**

$T = 18$ ms, so $\omega = (2\pi)/0.018 = 349$ rad/s and $\theta = 349 \times 0.012 = 4.19\,rad = 240°$
$I = 20sin240° = -17.3$ A and $emf = IR = -17.3 \times 16.5 \approx -286$ V

46 **Answer (C)**

At $t = 10$ ms, $\varphi_m = 0$ and its rate of change is maximum
$emf = N\,\varphi_{max}\,\omega = 70 \times 0.02 \times (2\pi)/0.02 = 440$ V

47 **Answer (A)**

$\varphi_{max} = frac0.035cos45° = 0.035sqrt2 \approx 0.049$ Wb
After a quarter of a revolution $\varphi_m = 0$ and $emf = emf_{max} = N\,\varphi_{max}\,2\pi\,f =$
$8 \times 0.049 \times 2\pi \times 50 \approx 123.2$ V

48 **Answer (B)**

$\varphi_m = \varphi_{max}cos\theta$, so $emf = -N\,(\Delta\varphi_m)/(\Delta\,t) = emf_{max}sin\theta$: it starts from zero, increases, and completes one cycle.

49 **Answer (B)**

$emf_{max} = I_{max}\,(R + r) = 20 \times 10 = 200$ V and $\omega = 100\pi$
$\varphi_{max} = (emf_{max})/(N\omega) = 200/(100 \times 100\pi) = 6.36$ mWb, the periodic time $T = (2\pi)/(\omega)$ $= 20$ ms, and the flux starts from its maximum value (the emf starts from zero).

50 **Answer (D)**

During a complete revolution $\Delta\varphi_m = 0$, so the average emf is zero.

51 **Answer (B)**

The direction of the emf changes every half revolution.

52 **Answer (C)**

The average emf during half a revolution from the parallel position: $\Delta\varphi_m = 0$, so it is zero; but the instantaneous emf in the parallel position is maximum.

53 **Answer (B)**

$T = 0.8$ s, so a quarter of a revolution is $\Delta t = 0.2$ s

$emf_{avg} = N BA/(\Delta t) \Rightarrow 0.4 = (100 \times B \times 0.02)/0.2 \Rightarrow B = 0.04$ T

54 **Answer (C)**

$emf_{avg} = N\ 2BA/(T/2) = (4\ N\ B\ A)/T$ and $emf_{max} = (2\pi\ NBA)/T$

$emf_{avg} = 2/(\pi)\ emf_{max} = (2 \times 7)/22 \times 100 = 63.6$ V

55 **Answer (C)**

$emf_{max} = 50sqrt2 = 70.7$ V

A quarter of a revolution from the parallel position: $emf_{avg} = 2/(\pi)\ emf_{max} = 2/(\pi) \times 70.7 \approx 45$ V

56 **Answer (D)**

Half a revolution is 6 ms, so $\omega t = 180^\circ timest/6$: at 1 ms the angle is 30° and at 2 ms it is 60°

$x/y = fracsin30^\circ sin60^\circ = (1/2)/(sqrt3/2) = (sqrt3)/3$

57 **Answer (B)**

$emf_{avg} = -N\ (\Delta\varphi_m)/(\Delta t)$, and in the interval $0 \rightarrow 2t$: $\Delta\varphi_m = 2\varphi_{max}$, so the average $= (N\varphi_{max})/t$

In the interval $t \rightarrow 2t$: $\Delta\varphi_m = \varphi_{max}$ in a time t, so the average is the same.

58 **Answer (B)**

$\omega = (emf_{max})/NBA = 157/(100 \times 0.1 \times 0.05) = 314$ rad/s

59 **Answer (A)**

$f = (\omega)/(2\pi) = 314/(2 \times 3.14) = 50$ Hz

60 **Answer (D)**

A quarter of a revolution from the maximum position: $emf_{avg} = 2/(\pi)\ emf_{max} = 2/3.14 \times 157 = 100$ V

61 **Answer (C)**

Half the periodic time is 4 ms, so $\theta = 180^\circ \times (4/3)/4 = 60^\circ$

$emf_{max} = frac20sqrt3sin60^\circ = 40$ V

62 **Answer (B)**

After another $4/3$ ms, $\theta = 120^\circ$

$emf = 40sin120^\circ = 20sqrt3 = 34.6$ V

63 **Answer (B)**

$emf_{rms} = 40/(sqrt2) = 28.28$ V

$I_{rms} = (emf_{rms})/R = 28.28/10 = 2.828$ A

64 **Answer (D)**

During the quarter revolution $emf_{avg} = 2/(\pi)\ emf_{max}$, and at its end $emf = emf_{max}$

$(emf_{avg})/emf = 2/(\pi)$

65 **Answer (D)**

From the parallel position: $(emf)_0 = N\ fracBAsin60^\circ T/6$

From the perpendicular position: $emf = N\ (BA(1-cos60^\circ))/(T/6) = N\ (BA/2)/(T/6)$, and the ratio is $(1/2)/(sqrt3/2) = 1/(sqrt3)$, so it is $((emf)_0)/(sqrt3)$

66 **Answer (C)**

$emf_{max} = 240$ V

$emf_{rms} = 240/(sqrt2) = 120sqrt2$ V

67 **Answer (C)**

$\omega = 50\pi$, so $T = (2\pi)/(\omega) = (2\pi)/(50\pi) = 0.04$ s

68 **Answer (C)**

A quarter of a revolution is 5 ms, so $T = 20$ ms and $\omega = 100\pi$ rad/s

At 1 ms, $\omega\ t = 18^\circ$ and $\varphi_m = \varphi_{max}cos18^\circ = 3$ mWb, so $\varphi_{max} = 3.154$ mWb

$I_{max} = (N\ \varphi_{max}\ \omega)/(R_{total}) = (600 \times 3.154 \times 10^{-3} \times 100\pi)/10 = 59.4$ A

69 **Answer (A)**

$emf_{max} = 200sqrt2 \times sqrt2 = 400$ V and $\omega = 2\pi f = 2 \times 22/7 \times 50/11 = 200/7$ rad/s

$B = (emf_{max})/(NA\omega) = 400/(300 \times (0.4 \times 0.3) \times 200/7) = 7/18$ T

70 **Answer (C)**

$emf_{max} = 2NBLv = 2 \times 300 \times 7/18 \times 0.4 \times 3 = 280$ V (the side parallel to the axis is 0.4 m long)

71 **Answer (B)**

$emf_{max} = sqrt2\ emf_{eff} = 1.414 \times 88.8 = 125.6$ V

72 **Answer (A)**

$\omega = (emf_{max})/NBA = 125.6/(200 \times 0.1 \times 2 \times 10^{-2}) = 314$ rad/s

$f = (\omega)/(2\pi) = 314/(2 \times 3.14) = 50$ Hz

73 **Answer (C)**

$emf_{max} = 100sqrt2 = 141.42$ V

Half a revolution from the zero position: $emf_{avg} = 2/(\pi)\ emf_{max} = 2/(\pi) \times 141.42 \approx 90$ V

74 **Answer (B)**

$emf_{eff} = (NBA\omega)/(sqrt2)$, so it is directly proportional to A (a straight line through the origin)

75 **Answer (D)**

$T = 20$ ms, so $\omega = (2\pi)/T = (2 \times 22/7)/0.02 = 314.29$ rad/s

$I_{max} = 20$ A, so $I_{eff} = 20/(sqrt2) = 10sqrt2$ A

76 **Answer (B)**

$I_{max} = sqrt2\ I_{eff} = 1.414 \times 2.828 = 4$ A

77 **Answer (A)**

$I = I_{max} sin\theta = 4sin30^\circ = 2$ A

78 **Answer (A)**

$I_{max} = sqrt2 \times 3.535 = 5$ A

The coil makes 60° with the flux, so the angle with the normal is 30°: $I = 5sin30^\circ = 2.5$ A

79 **Answer (A)**

$I_{max} = sqrt2 \times 3.535 = 5$ A and $T = 1/50 = 0.02$ s

$1/200$ s $= T/4$, so the current is at its maximum value, 5 A

80 **Answer (B)**

$I_{max} = 10sqrt2$ A, and after a quarter of a revolution from zero the current reaches its maximum value $10sqrt2$ A

81 **Answer (B)**

$1/8$ of a revolution means $\theta = 45^\circ$

$I = 10sqrt2sin45^\circ = 10$ A

82 **Answer (C)**

$I_{max} = (V_{max})/R = 200/50 = 4$ A

83 **Answer (C)**

$I_{eff} = (I_{max})/(sqrt2) = 4/(sqrt2) = 2.828$ A

84 **Answer (C)**

Replacing the two rings by a split cylinder (commutator) changes the current into a unidirectional current and does not increase the effective value, while increasing the speed, the turns or the field increases $emf_{max} = NBA\omega$

85 **Answer (A)**

From 0 to $I_0/2$: $sin\theta = 1/2$, so $\theta = 30^\circ$

From the maximum to half of it is 60°, which takes t_0, so the time of $30^\circ = t_0/2$

86 **Answer (D)**

The second time is at $\theta = 150^\circ$, that is $2.5 \times 60^\circ$

$t = 5/2\ t_0$

87 **Answer (D)**

The effective value $I_0/(sqrt2)$ is reached at $\theta = 45^\circ$

$t = 45/60\ t_0 = 3/4\ t_0$

88 **Answer (B)**

$60^\circ \rightarrow t_0$, so a complete cycle of 360° needs $6t_0$

89 **Answer (C)**

From zero to half the maximum, $\theta = 30^\circ$ takes t; to the maximum, $\theta = 90^\circ$, so it takes $3t$

90 **Answer (C)**

$I = (sqrt3)/2 I_0 \Rightarrow \theta = 60^\circ = T/6$ and $T = 1/25$ s

$t = 1/(6 \times 25) = 1/150$ s

91 **Answer (B)**

The coil in the figure is parallel to the field, so the current reverses when the coil passes the perpendicular position after $1/4$, then $3/4$, then $5/4$ of a revolution

That is three times during one and a half revolutions.

92 **Answer (C)**

$f = 20/0.4 = 50$ Hz

The current reaches 5 A (the maximum value) twice in each cycle (positive and negative): $2 \times 50 = 100$ times

93 **Answer (B)**

The current is zero every half cycle, and in 1 s there are 50 cycles, that is 100 half cycles

Counting the starting moment: $100 + 1 = 101$ times

94 **Answer (C)**

The effective value $(I_{max})/(sqrt2)$ occurs 4 times in each cycle (at 45°, 135°, 225° and 315°)

$4 \times 100 = 400$ times

95 **Answer (C)**

The current reverses twice in each cycle, that is $n = 2f t$

$f = n/2t$

96 **Answer (B)**

$R = 100 \times 0.01 = 1\ \Omega$ and $T = 1/50 = 0.02$ s

$E = I_{eff}^2 R T \Rightarrow I_{eff}^2 = 2/(1 \times 0.02) = 100 \Rightarrow I_{eff} = 10$ A

$emf_{max} = sqrt2\ I_{eff} R = 1.414 \times 10 = 14.14$ V

97 **Answer (D)**

ωt is in degrees: $\omega = 18000^\circ/s$

$f = 18000/360 = 50$ Hz

98 **Answer (D)**

$\theta = 18000 \times 5 \times 10^{-3} = 90^\circ$

$emf = 200 sin 90^\circ = 200$ V

99 **Answer (A)**

$V_{\text{eff}} = 200/(sqrt2)$ and $T = 1/50 = 0.02$ s

$E = (V_{\text{eff}}^2)/R\ T = 20000/20 \times 0.02 = 20$ J

100 **Answer (D)**

$P = I_{\text{eff}}^2 R \Rightarrow I_{\text{eff}} = \sqrt{(200/8)} = 5$ A

$I_{\max} = sqrt2 \times 5 = 7.072$ A and $V_{\max} = I_{\max} R = 7.072 \times 8 = 56.58$ V

101 **Answer (C)**

$P_{\text{avg}} = V_{\text{eff}}\, I_{\text{eff}} = (V_{\max})/(sqrt2) \times (I_{\max})/(sqrt2) = (50 \times 10)/2 = 250$ W

102 **Answer (A)**

Each coil has two insulated halves of the cylinder (commutator), so the number of parts is twice the number of coils: $1/2$

103 **Answer (C)**

The commutator reverses the current every half cycle, so it becomes unidirectional and its frequency becomes $2f = 100$ Hz (two pulses in each cycle)

104 **Answer (C)**

The split metal cylinder (commutator) (3) is what makes the current unidirectional.

105 **Answer (B)**

Side ab moves out of the page and the field is from N to S, so the right-hand rule gives a current in side ab from a to b

So the current leaves from end d to brush F_2, which is the positive one, and the commutator reverses the connection every half revolution, so F_2 stays positive in both halves of the revolution.

106 **Answer (B)**

The current in the resistance is from F_1 to F_2, so the coil current leaves from end x, that is it flows in side xy from y to x (downwards)

The field is from A to B, so to generate a downward current by the right-hand rule, the side moves into the page and the poles are $A = N$ and $B = S$

107 **Answer (A)**

The insulating gap between the two halves of the cylinder is perpendicular to the plane of the coil, so the angle between them is 90°

108 **Answer (A)**

The current reaches zero twice per cycle and returns in one direction only, which needs a cylinder of only two parts (one coil).

109 **Answer (C)**

The insulating material touches the two brushes at the moment the current is zero, that is at t_3

110 **Answer (C)**

The alternating current from the position perpendicular to the field starts from zero (sin): figure (3)

111 **Answer (B)**

The alternating current from the position parallel to the field starts from its maximum value (cos): figure (2)

112 **Answer (A)**

A DC dynamo with one coil gives a pulsating current that reaches zero every half cycle: figure (1)

113 **Answer (D)**

The two perpendicular coils give two currents, one lagging by $90°$, and the resulting current is the upper envelope of the two curves, so it does not reach zero and ripples between I_{max} and $0.7I_{max}$: figure (5)

Essay questions

1 **Model answer**

(1) When the handle is turned, the coil rotates between the magnet poles, so the magnetic flux cutting the coil changes and an induced emf is generated between its ends. This causes an alternating induced current to flow in the lamp filament, so it lights up.

(2) When the handle is turned faster, these increase: the effective and maximum values of the current, and the frequency of the current.

(3) The brightness stays the same, because it does not depend on the direction of the current.

2 **Model answer**

(1) $\theta = 2\pi f t : 90 = 2 \times 180 \times f \times 1/200 , f = 50\ Hz$

$(emf)_{max} = NAB \times 2\pi f = 420 \times 3 \times 10^{-3} \times 0.5 \times 2 \times 22/7 \times 50 = 198\ V$

(2) $emf = (emf)_{max} sin\theta = ((emf)_{max})/2 , sin\theta = 1/2 , \theta = 30^\circ$

$30 = 2 \times 180 \times 50\ t , t = 1/600\ s$

3 **Model answer**

$emf = (emf)_{max} sin\theta , 10 = (emf)_{max} sin\ 45^\circ$

$(emf)_{max} = 10\sqrt{(2)}\ V$

4 **Model answer**

(1) $((emf)_{max})/(\sqrt{(2)}) = (emf)_{max} sin(2 \times 180 f \times 0.01) , f = 12.5\ Hz$

$(emf)_{max} = N(\varphi_m)_{max} \times 2\pi f = 100 \times 0.02 \times 2 \times 22/7 \times 12.5 = 157.14\ V$

(2) $(emf)_{eff} = ((emf)_{max})/(\sqrt{(2)}) = 157.14/(\sqrt{(2)}) = 111.11\ V$

5 **Model answer**

(1) $\omega = 2\pi f = 100\pi , f = 50\ Hz$

(2) $(emf)_{max} = NBA\omega = 100\pi\ BA , N = 1$

6 **Model answer**

Because the values of the current during the first half of the cycle equal the values during the second half but in the opposite direction, so the average value of the alternating current during a complete cycle is zero. But the rate of electrical energy (the electric power) consumed during a complete cycle is not zero, because the electrical energy is consumed as heat due to the motion of the electrons inside the conductor, whatever their direction.

7 **Model answer**

$(emf)_{max} = NBA \times 2\pi f$

$(emf)_{avg} = -N(\Delta \varphi_m)/(\Delta t) = -NBA(cos\ 60^\circ - cos\ 0)/(1/6f) = 3NBAf$

$((emf)_{avg})/((emf)_{max}) = 3NBAf/(NBA \times 2\pi f) = 3/(2\pi)$

8 **Model answer**

The average emf during a quarter of a revolution from the zero position: $(emf)_{1/4} = N(\varphi_m)/(T/4)$

When the coil rotates half a revolution from the zero position, both the change in the flux cutting the coil and the time taken are twice those of a quarter revolution, so the rate of change of flux stays the same:

$(emf)_{1/2} = N(2\varphi_m)/(T/2) = N(\varphi_m)/(T/4)$

9 **Model answer**

$(emf)_{avg} = -N(\Delta \varphi_m)/(\Delta t) = -150 \times ((-4 - 0) \times 10^{-5})/((5 - 2.5) \times 10^{-3}) = 2.4\ V$

$I_{avg} = ((emf)_{avg})/R = 2.4/5 = 0.48\ A$

10 **Model answer**

(1) Point (C), because the induced emf is zero when the plane of the coil is perpendicular to the direction of the magnetic field.

(2) $22.5 = 45\sin\theta$, $\theta = 150°$ (because the coil starts from the parallel position, $\theta = 90°$)

So the coil rotates through $150 - 90 = 60°$

$T = 0.75 \times 10^{-3} \times 4 = 3 \times 10^{-3}\ s$, $f = 1000/3\ Hz$

$60 = 2 \times 180 \times 1000/3 \times t$, $t = 5 \times 10^{-4}\ s$

11 **Model answer**

$T = 1/f = 1/10 = 0.1\ s$

(1) The flux is zero when the plane of the coil is parallel to the field, that is after a quarter of a revolution: $t = T/4 = 1/40\ s$

(2) The emf is maximum when the plane of the coil is parallel to the field, that is after a quarter of a revolution: $t = 1/40\ s$

(3) The current becomes zero when the coil is perpendicular to the flux lines, that is after half a revolution: $t = T/2 = 1/20\ s$

(4) The average emf becomes zero when the coil completes a full revolution, that is after 0.1 s

(5) The instantaneous emf equals the effective emf when the plane of the coil makes an angle of 45° with the field, that is after $1/8$ of a revolution: $t = T/8 = 1/80\ s$

12 **Model answer**

During the interval from 0 to t (a quarter of a revolution): $(emf)_1 = -N(0 - BA)/(1/4T) = NBA \times 4f$

During the interval from 0 to 3t (three quarters of a revolution): $(emf)_2 = -N(0 - BA)/(3/4T) = NBA \times 4/3f$

Comparing: $(emf)_1 > (emf)_2$

13 **Model answer**

$f = 1/T = 1/(8 \times 10^{-3}) = 125\ Hz$

(1) $(\varphi_m)_1 = BA\cos 90° = 0$, $(\varphi_m)_2 = BA\cos 270° = 0$, so the average emf = 0

(2) $((emf)_{avg})/((emf)_{max}) = -(\cos\theta_2 - \cos\theta_1)/(2\pi f \Delta t)$

$((emf)_{avg})/100 = -fraccos\ 180° - \cos 135° 2 \times 22/7 \times 125 \times 1 \times 10^{-3}$, $(emf)_{avg} = 37.28\ V$

14 **Model answer**

(1) $(emf)_{max} = NBA\omega$, slope = NBA

(2) $(emf)_{max} = NBA \times 2\pi f$, slope = 2πNBA

(3) $(emf)_{max} = NBA\omega$, slope = BAω

(4) $emf = NBA\omega sin\theta$, slope = NBAω

(5) $I_{eff} = (I_{max})/(\sqrt{(2)})$, slope = $1/(\sqrt{(2)})$

(6) $(emf)_{eff} = ((emf)_{max})/(\sqrt{(2)})$, slope = $1/(\sqrt{(2)})$

15 **Model answer**

The maximum induced emf increases to four times its value according to $(emf)_{max} = NBA \times 2\pi f$

The effective emf also increases to four times its value according to $(emf)_{eff} = ((emf)_{max})/(\sqrt{(2)})$

16 **Model answer**

(1) The maximum induced emf in the coil does not change, because it is given by $(emf)_{max} = NBA\omega$ and all these quantities are constant.

(2) The maximum current through the coil increases, because it is given by $I_{max} = ((emf)_{max})/(R')$ and the resistance of the external circuit has decreased.

17 **Model answer**

Using a battery: $(P_w)_1 = (V_B^2)/R = 144/R$

Using the dynamo: $(P_w)_2 = (V_{eff}^2)/R = ((12)^2)/2R = 72/R$

$(P_w)_1 > (P_w)_2$, so the lamp is brighter when the battery is used.

18 **Model answer**

The current generated in the dynamo coil: alternating current (changing in magnitude and direction).

The current in its external circuit: a unidirectional current of changing magnitude.

19 **Model answer**

(1) Two perpendicular coils connected to a metal cylinder split into four parts insulated from each other.

(2) Several coils with small equal angles between them are used, and the hollow metal cylinder is divided into a number of insulated parts equal to twice the number of coils.

Past exam questions

1	2	3	4	5	6	7	8	9	10
B	B	C	A	A	A	C	D	C	D
11	12	13	14	15	16	17	18	19	20
A	D	B	A	C	B	A	B	A	A
21	22	23	24	25	26	27	28	29	30
C	C	C	C	B	B	B	A	D	C
31	32	33	34	35	36				
D	D	D	C	A	—				

1 **Answer (B)**

$(emf)_{max} = NBA\omega$, with the same B and ω: $(emf)_{max} \propto NA$

(a) 20A , (b) 40A , (c) 30A , (d) 10A

Ascending order: d then a then c then b

2 **Answer (B)**

The voltage reaches its maximum value twice every cycle: $f = 50\ Hz$

$(emf)_{max} = NBA \times 2\pi f = 100 \times 0.2 \times 250 \times 10^{-4} \times 2\pi \times 50 = 157.1\ V$

$(emf)_{eff} = 157.1/(\sqrt{(2)}) = 111.1\ V$

3 **Answer (C)**

$(emf)_{max} = NBA \times 2\pi f \propto Nf$

Dynamo y: twice the number of oscillations of x, so $f_y = 2f_x$, and half the maximum voltage.

$V_0/2V_0 = (N_y \times 2f_x)/(N_x f_x)$, $N_y/N_x = 1/4$

4 **Answer (A)**

$(emf)_{max} = NBA \times 2\pi f = 12 \times 0.6 \times 0.08 \times 2 \times 22/7 \times 50 = 181\ V$

$I_{max} = 181/22 = 8.23\ A$

5 **Answer (A)**

$P = I_{eff}^2 R$, $I_{eff} = \sqrt{(60/30)} = \sqrt{(2)}\ A$

$I_{max} = \sqrt{(2)}\ I_{eff} = 2\ A$

6 **Answer (A)**

$T = 0.08\ s$, $f = 12.5\ Hz$, $\theta = 360 \times 12.5 \times 1/75 = 60°$

$(emf)_{avg} = (emf)_{max} frac1 - \cos 60° 2\pi f t = (100 \times 0.5)/(2 \times 3.14 \times 12.5 \times 1/75) = 47.77\ V$

7 **Answer (C)**

$(emf)_{avg} = N2BA/(T/2) = 4NBAf = 4 \times 100 \times 0.1 \times 0.02 \times 50 = 40\ V$

8 **Answer (D)**

$10 = (emf)_{max} sin\ 45^\circ$, $(emf)_{max} = 10\sqrt{(2)}\ V$

During $1/3$ of a revolution: $\theta = 120^\circ$

$(emf)_{avg} = (emf)_{max} frac1 - cos\ 120^\circ 2\pi \times 1/3 = (10\sqrt{(2)} \times 1.5)/2.094 = 10.1\ V$

9 **Answer (C)**

The emf reaches half its maximum value for the second time at $\theta = 150^\circ$

$150 = 360 \times f \times 1/60$, $f = 25\ Hz$

10 **Answer (D)**

$T = 0.04\ s$, $f = 25\ Hz$, $\theta = 360 \times 25 \times 1/30 = 300^\circ$

$(emf)_{avg} = (emf)_{max} frac1 - cos\ 300^\circ 2\pi\ f\ t = (200 \times 0.5)/(2 \times 3.14 \times 25 \times 1/30) = 19.1\ V$

11 **Answer (A)**

The instantaneous emf is zero when the flux is maximum (its rate of change is zero): at t_1 , t_3

12 **Answer (D)**

$\omega = ((emf)_{max})/NBA = 376.99/(200 \times 0.3 \times 0.01) = 628.3 = 200\pi\ rad/s$

13 **Answer (B)**

The dynamo is connected to two metal rings, so it produces an alternating current: curve x , $I_{max} = 3\ A$

$(emf)_{max} = I_{max} R = 3 \times 10 = 30\ V$

$(emf)_{avg} = 2/(\pi)(emf)_{max} = (2 \times 30)/3.14 = 19.11\ V$

14 **Answer (A)**

$1/4$ of a revolution from the perpendicular position: $\Delta\ \varphi_m = BA$, and $1/2$ a revolution: $\Delta\ \varphi_m = 2BA$

In the same time: the ratio $= BA/2BA = 0.5$

15 **Answer (C)**

The emf reaches half its maximum value for the second time at $\theta = 150^\circ$

$t = 150/(360 \times 50) = 1/120\ s$

16 **Answer (B)**

$(emf)_{max} = NBA \times 2\pi f = 200 \times 0.02 \times 0.1 \times 2\pi \times 50 = 125.7\ V$

During 5 ms (a quarter of a revolution) from the perpendicular position, the emf increases from zero to the maximum value.

17 **Answer (A)**

Half a revolution is 0.04 s, so at t = 0.01 s the angle is 45°

$6 = (emf)_{max} sin\ 45°$, $(emf)_{max} = 6\sqrt{(2)}\ V$

$(emf)_{eff} = ((emf)_{max})/(\sqrt{(2)}) = 6\ V$

18 **Answer (B)**

$(emf)_{max} = NBA \times 2\pi f = 300 \times 0.01 \times 0.02 \times 2 \times 22/7 \times 1400/60 = 8.8\ V$

The plane of the coil makes 60° with the field, so its normal makes 30°

$emf = 8.8\ sin\ 30° = 4.4\ V$

19 **Answer (A)**

$f = 6000/60 = 100\ Hz$

$(emf)_{max} = 200 \times 0.02 \times 0.02 \times 2 \times 3.14 \times 100 = 50.24\ V$

$(emf)_{eff} = 50.24/(\sqrt{(2)}) = 35.53\ V$

20 **Answer (A)**

The flux at the start and the end of the interval is zero, so there is no total change in flux: $(emf)_{avg} = 0$

21 **Answer (C)**

The flux decreases from its maximum value to zero in 2 ms (a quarter of a revolution): $T = 8\ ms$, $f = 125\ Hz$

$\theta = 360 \times 125 \times 0.1 \times 10^{-3} = 4.5°$

$emf = N\varphi_m \times 2\pi f\ sin\theta = 200 \times 2 \times 10^{-6} \times 2 \times 3.14 \times 125 \times sin\ 4.5° = 0.025\ V$

22 **Answer (C)**

The instantaneous value equals the effective value at 45°, that is after $1/8$ of a revolution.

$t = T/8 = 20/8 = 2.5\ ms$

23 **Answer (C)**

$(emf)_{avg} = N(\Delta\varphi_m)/(\Delta t) = (200 \times 3.5 \times 10^{-3})/(5 \times 10^{-3}) = 140\ V$

24 **Answer (C)**

The instantaneous emf is zero when the flux is maximum (its rate of change is zero): at A , C

25 **Answer (B)**

$(emf)_{eff} = (50\sqrt{(2)})/(\sqrt{(2)}) = 50\ V$, $I = 50/500 = 0.1\ A$

Circuit (B): $I = 10/100 = 0.1\ A$

26 **Answer (B)**

From the parallel position: $\varphi_m = (\varphi_m)_{max} sin\theta$, $10 = (\varphi_m)_{max} sin\ 30^\circ$, $(\varphi_m)_{max} = 20\ mWb$

$(emf)_{max} = N(\varphi_m)_{max} \times 2\pi f = 50 \times 0.02 \times 2 \times 3.14 \times 50 = 314\ V$

27 **Answer (B)**

The current generated inside the dynamo coil is alternating and changes its direction every half revolution; the rectifier (the split cylinder) makes its direction the same in the external circuit only.

28 **Answer (A)**

The coil is connected to two metal rings, so an alternating current flows in the resistance: graph (A).

29 **Answer (D)**

The angle is in degrees: $\theta = 18000\ t$

$-100 = 200sin\theta$, the first time is at $\theta = 210^\circ$

$t = 210/18000 = 7/600\ s$

30 **Answer (C)**

From the figure: T = 20 ms, and ε = 30 V at ⅛ of a revolution (45°), so $\varepsilon_{max} = 30\sqrt{(2)}\ V$ and $\varepsilon_{eff} = 30\ V$

When ω is doubled: $T = 10\ ms$, and the effective value doubles: 60 V

31 **Answer (D)**

Half a revolution is 20 ms: $T = 40\ ms$, $f = 25\ Hz$, and at t = 5 ms: θ = 45°

$200 = \varepsilon_{max} sin\ 45^\circ$, $\varepsilon_{max} = 200\sqrt{(2)}\ V$

At x the coil is perpendicular to the field, so the flux is maximum:

$(\varphi_m)_{max} = (\varepsilon_{max})/(N \times 2\pi f) = (200\sqrt{(2)})/(100 \times 2 \times 3.14 \times 25) = 1.8 \times 10^{-2}\ Wb$

32 **Answer (D)**

The coil starts rotating from the perpendicular position, so an alternating current is generated that starts from zero and changes its direction: graph (D).

33 **Answer (D)**

During op (a quarter of a revolution), the flux changes by BA in a time $T/4$

During qn (half a revolution), the flux changes by 2BA in a time $T/2$, so the value is the same.

34 **Answer (C)**

The periodic time is 12t, so each t corresponds to 30°

From 2t to 7t: from 60° to 210° , $|cos\ 60° - cos\ 210°| = 1.366$

From 5t to 10t: from 150° to 300° , $|cos\ 150° - cos\ 300°| = 1.366$

The same change in flux in the same time 5t: the ratio = 1

35 **Answer (A)**

$50 = 100sin\theta$: at t_1 the angle is 30°, and at t_2 the angle is 150°

$(emf)_{avg} = (emf)_{max} fraccos\ 30° - cos\ 150° \Delta\theta = (100 \times 1.732)/((2\pi)/3) = 82.7\ V$

36 **Model answer**

For the wire of length (ℓ): $A_1 = ((\ell)/4)^2 = (\ell^2)/16$

For the wire of length (2ℓ): $A_2 = ((2\ell)/4)^2 = (\ell^2)/4$

$(emf)_{max} = NBA\omega$ and N, B and ω are all constant.

$V_1/V_2 = A_1/A_2 = 1/4$, $V_2 = 4V$